The Engineer

LONDON, FRIDAY, NOVEMBER 13, 1942.

SITUATIONS OPEN

ES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.
the benefit of applicants, the Proprietors pared to insert brief notices that vacancies lled, upon receipt of notifications from the ertisers. These notices (limited to one line) be free of charge, and co-operation is for.

IMPORTANT

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The Engineer

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SITUATIONS OPEN

THE Post You are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

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MISCELLANEOUS

BOUND VOLUMES or COPIES of "THE ENGINEER," January to June, 1932, and January to June, 1937, WANTED.—Address, F. M. P. (or telephone Central 6565), The Engineer Office. 8873 I

URGENTLY REQUIRED, ONE COPY of "ENGINEERING WORKSHOP PRACTICE," Volume 1, by Orland William Boston. Address, 8974, The Engineer Office. 8974 I

PATENTS

THE PROPRIETOR of BRITISH PATENT No. 512,749, dated February 25th, 1939, relating to "Tractor Hitch," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN and CARLBERG, Steger Building, Chicago, Illinois. 8990 H

THE PROPRIETORS of BRITISH PATENTS Nos. 473,754, 473,805, and 473,819 are PREPARED to SELL the PATENTS or to LICENSE British manufacturers to work thereunder. They relate to projectiles.—Address, BOULT, WADE and TENNANT, 112, Hatton Garden, London, E.C.1. 8995 H

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
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The Engineer

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***Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of* THE ENGINEER.**

Postal Address,
28, Essex Street, Strand, London, W.C.2.

Teleg. Address,
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Director of Studies, College of Estate Management, London.

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NEW LANCASHIRE BOILER, Dish 25ft. long by 9ft. 3in. diameter, working pressure. Immediate deli CLAYTON, SON and CO., Ltd., Mou Works, Hunslet, Leeds.

For continuation of Small Adver ments see page 60.

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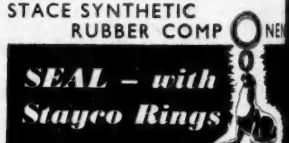

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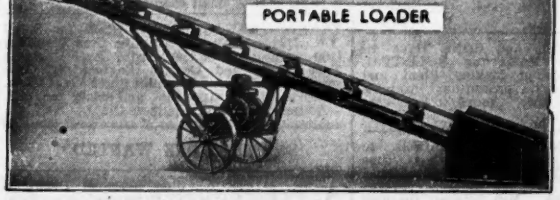

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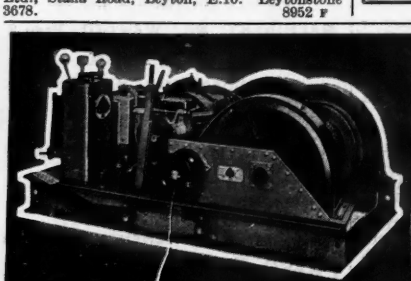

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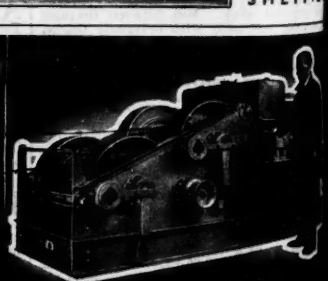


A Seven-Day Journal

Building and Civil Engineering Advisory Council

THE Minister of Works and Planning has appointed an Advisory Council representing the employer, operative, and professional sides of the building and civil engineering industries for the examination and mutual consideration of problems and policies affecting the present and future position of these industries in relation to the demands of the country's building and civil engineering requirements. The members of the Council have been nominated by their respective bodies as follows :—Mr. T. Howarth, Sir Jonah Walker-Smith, Mr. G. H. Parker, National Federation of Building Trades Employers ; Mr. A. G. Hutton, Scottish National Building Trades Federation (Employers) ; Mr. Henry T. Holloway, Mr. J. Crowley, Mr. N. H. LeMare, Federation of Civil Engineering Contractors ; Mr. J. W. Stephenson, Mr. Bruce Sandercock, Mr. Luke Fawcett, Mr. R. Coppock, National Federation of Building Trades Operatives ; Mr. Tom Pugh, Mr. H. Bullock, Civil Engineering Conciliation Board ; Mr. W. H. Ansell, P.R.I.B.A., Mr. Hubert Worthington, F.R.I.B.A., Royal Institute of British Architects ; Sir Peirson Frank, M. Inst. C.E., Mr. W. T. Halcrow, M. Inst. C.E., Institution of Civil Engineers ; Mr. Alan W. Davson, Mr. Alexander H. Purdie, Chartered Surveyors' Institution. Mr. G. H. Parker has been elected Chairman, and Mr. J. W. Stephenson Vice-Chairman of the new Council.

The Late John Henry Osborne

IT is with deep regret that we learn of the sudden death of Mr. John Henry Osborne, who since 1917 has been the chairman and managing director of Merryweather and Sons, Ltd., fire engineers, of London and Greenwich. Mr. Osborne, who was seventy-four years of age, died at his home, "Crombhayes," Kidbrooke Grove, Blackheath, on Sunday last, November 8th. He spent his early childhood at the San Domingo Mines in Portugal, where his father held the position of mining engineer and manager. Coming to England, he received his education at Tavistock Grammar School, and shortly afterwards returned to the mines at San Domingo, where for some years he studied engineering. In 1891 he returned to this country and was appointed to the staff of Merryweather and Sons, taking charge of the firm's foreign correspondence and overseas work. In carrying out these duties Mr. Osborne travelled twice round the world and opened new avenues to British industry. In 1910 he was elected to the board of Merryweather and Sons, and seven years later he was made chairman and managing director of the company, a post he continued to hold with distinction until his death. He was an associate of the Institute of Fire Engineers and he did much to advance the science of fire fighting and fire engineering. His death will be regretted by many friends, both at home and abroad.

Absenteeism and De-Reservation

IN one of to-day's leading articles we refer to the Seventeenth Report of the Select Committee on National Expenditure dealing with merchant shipbuilding and repairs. In that report the Committee makes reference to absentee rates of about 10 per cent., and the absenteeism and bad timekeeping of a minority of workers. The difficulties of dealing with this problem are discussed. In a previous Report, de-reservation was suggested by the Committee and was accepted by the Government, but it has not been put into practice. In its present Report the Committee says that the reservation of men of military age can only be justified on the ground that they are doing work of national importance. If they are not doing such work satisfactorily, the Committee is strongly of the opinion that reservation should be withdrawn. It fully appreciates the objections raised by the Government to allowing enlistment in the Forces to be regarded as a penalty for industrial offences, but considers that the small minority of workers in question would be better employed in the Fighting Services—a view which received support from representatives of the workers themselves. It therefore recommends that the Yard Committees should be given power to recommend de-reservation to the National Service Officer. De-reservation, it says, would be a satisfactory way of dealing with the large majority of young offenders, but obviously has no application to those under the age of military service. The Committee is not satisfied with the way in which the Ministry of Labour appears to be handling this problem. It has particularly in mind the case of four youths of seventeen years of age who were reported by a Yard Committee to the National Service Officer in October of last year. The National Service Officer interviewed them, but the youths did not improve. Further reports of unpunctuality were received on them between the beginning of November and the end of March, and directions under the Essential Work Order were issued in all four cases between the last week of January and the second week of March. The directions did not prove effective, and about the end of May the National Service Officer advised the employers that the cases would be referred for consideration of prosecution, but such action was not in fact taken. The Ministry of Labour admits that there was weakness on the part of the National Service Officer, but it points out that the failure to take action was partly due to the deliberate policy of the Ministry not to prosecute juveniles except in flagrant cases and after all alternative corrective measures have failed.

The Late Major Arthur Samuel Rice, R.E.

A LINK has been severed with engineering work in the Middle East by the recent death, at Larbert, of Major Arthur Samuel Rice, R.E., who carried out considerable engineering work in Greece and the Middle East. Major Rice, who was trained as a mechanical and electrical engineer, was educated at the City and Guilds Engineering College, South Kensington, and afterwards occupied the position of transport engineer with the General Motors Corporation in the United States, Europe, and the Middle East. One of his principal tasks was the supervising of the labour used in the construction of the 600-mile pipe in Iraq for the Iraq Petroleum Company, Ltd., from its oilfield in the vicinity of Kirkuk in Iraq, to the Mediterranean ports of Haifa, in Palestine, and Tripoli, in Lebanon. In the course of that work, which was carried out from 1932 to 1934, Major Rice had charge of 40,000 men. In addition, he carried out oil well boring operations in America and in Greece, and was also engaged on the construction of harbour works and landing grounds in Asia Minor. During the last war he saw service in the Gallipoli, Palestine, and Syria campaigns, and was in the Suez Canal defence area and in Greece. For his services he was awarded three decorations. When the present war broke out Major Rice again joined the Royal Engineers and went through the initial stages of the Egyptian campaign. He received an injury from bomb blast at Tobruk, but after spending some time in hospital he was posted to the intelligence section of the Army in the western desert. Unfortunately, his injury reasserted itself, and he was invalided to South Africa and later to Scotland, where he died.

A National Policy for Industry

A STATEMENT issued on Wednesday last puts forward certain views and recommendations as to the place which industry should occupy in the framework of society. It is offered by a group of industrialists as a contribution to current discussions on reconstruction. The signatories state their aim as being "to assure to the consumer the full benefit of constant technical progress reflected in higher quality or lower prices or both, while at the same time establishing greater economic security for all than heretofore—security from violent fluctuations in employment, in the returns to industry, in the currents of domestic and international trade." It appears to them, therefore, to be an essential condition of progress that the relations between firms, between different industries, and between industry as a whole and Government should be more fully and comprehensively organised in some form of permanent association. The first step should be the classification of industries into sections, as has already been done in many branches of industry. Each section should set up a sectional association, which, operating, where necessary, through local or sub-associations, would be charged with the duties of co-ordinating the activities and securing the collaboration of all producers in its own section. There ought also to be brought into being a Central Council of Industry, representative of the whole of industry, and an Industrial Tribunal or Commission. The last-named would be in the nature of a final court of appeal on all industrial matters and would be appointed, not by industry itself, but by the Government. The signatories add that they do not claim to have put forward a solution of all the problems with which industry and the community are jointly faced, and stress that the proposals sketched in this interim statement need to be examined, developed, and elaborated. In order to see that these suggestions are more fully examined and developed, a Committee is to be appointed to examine the suggestions in detail and to submit a report. The preliminary report is issued in pamphlet form by Messrs. Thomson McLintock and Co., Granite House, Cannon Street, E.C.4.

American Post-War Transport

IN a report of the Resources Planning Board, which has recently been sent to the United States Congress by President Roosevelt, far-reaching alterations in the organisation of America's post-war transport is recommended, which, if agreed to, will be carried out under a new Federal agency. In general, the report, which is the fifth of a series of post-war planning studies, prepared by a committee under the chairmanship of Mr. Owen D. Young, recommends the consolidation of all the present Government transport organisations under one large group. That group would be responsible for the railways and the other systems of transport, the construction of terminal stations, the co-ordinating of present transport systems, and the encouragement of new forms of transport. In a letter which accompanied the report, Mr. Owen Young points out that by the end of the war millions of men would be released from wartime activities, and the need to find employment for them would coincide with very large demands for labour, if the modernisation of American transport be undertaken with vision, courage, and practical judgment. No better time, Mr. Owen Young says, could be found for undertaking a major reorganisation of transport facilities. The report of the Resources Planning Board deals with the Government planning of air transport, in order to establish air travel as a major integral part of transport policy ; the Federal financing of railway modernisation and improvement as a public works programme ; the restoration of motor road transport on a modern and efficient basis, with emphasis on express highways ; and Government planning for the economic consolidation of the existing railway systems into a limited number of systems arranged on regional lines, but avoiding systems of excessive size. All these matters are dealt with in considerable detail.

Practical Road Transport Operation with Producer Gas

By J. E. BIRCHALL

History

GAS producers, particularly stationary units, have been in general commercial use for a considerable period. A stationary unit has the very great advantage that the size and weight of the components are not vital factors. Hence material used can be selected by reference to its suitability for the work without any limiting factors. Filtering units can also be made without limitations of this nature. For instance, running water from a main can be utilised. A portable unit, on the other hand, suffers from all these disabilities and restrictions.

After its success as a stationary unit attention was turned to development as a portable unit, particularly on the Continent. For a number of years now portable gas producer units have been used in considerable numbers there, using chiefly charcoal and dried wood, which are readily available in quantity, as the fuel. These units were, in the main, of the simplest possible construction, but the use of these fuels had an important influence on the adoption of gas producers at a later date in this country.

Early Experience

Shortly after the outbreak of war my company became anxious about the liquid fuel position, as, in spite of very stringent economies, amounting to a conservation of fuel of 25 per cent. of pre-war consumption, further restrictions were enforced.

Accordingly, it was decided to investigate the possibilities of producer gas, after consideration had been given to coal gas and alternative liquid fuels. Practically all existing types were considered and some actually tested, the engine capacities being in the ¾-litre class.

In March, 1940, a B.V.P. model "C" cross draught with cooler and vertical sisal filter was purchased and installed on a 1937 25 H.P. (3485 c.c.) Morris box van which had covered 74,143 miles on petrol. No loading space was sacrificed, although the unit was built in. Summarised results of this and other producers are given in tabular form. This apparatus would function satisfactorily on the whole with Suncole fuel, but the water injection and filter were most unreliable. The water injection was dispensed with and the filter radically altered to include an oiled coke trap, wire wool, and sisal and an oil cleaner. The cooler was removed from the top of the cab to alongside the chassis. When Suncole became unavailable various fuels were used, not always satisfactorily. It was found that a cross draught developed high local heat—which on two occasions set the cab on fire—excessive clinker, much dust, and used to channel badly. The latter causes a sudden and unexpected stop due to lack of gas.

Experience with Up-draught Producers

Owing to a search for better filtration and more reliability, the C. and W. up-draught producer, with dry blast, cooler and vertical wood shavings filter was investigated and one was purchased and installed in September, 1940, on the sister machine to that fitted with the B.V.P. The former had then run exactly 83,000 miles on petrol. Being an up-draught, this producer was cooler, but persistent trouble with tuyères was experienced. The filter was modified in endless ways without achieving efficiency. The general performance, however, was much better, and accordingly the B.V.P. was converted to a C. and W. up-draught with our own modifications to the C. and W. filter. Generally speaking, these two units, which were in use fifteen months and twelve months respectively, gave a reasonably good performance, so that journeys of over 500 miles in length were made with them. In all, forty-nine such journeys between November, 1940, and November, 1941, were made—a regular weekly service, in fact—and it speaks well of the equipment that they always returned under their own gas power, except for three occasions when, owing to repeated tuyère trouble, the journeys were completed on petrol. Great care in preparing these units beforehand was necessary to ensure, if possible, a satisfactory run. Apart from filtering and tuyères, the main difficulties experienced were corroded pipes and choked manifolds due to tarry deposits.

Further Investigations

Corrosion and tar were, of course, serious obstacles to efficient maintenance and reliability, and in the course of investigations and experiments contact was made with the British Coal Utilisation Research Association, and through them with the I.C.I. (Alkali), Ltd. (research department). They convinced us that the B.C.U.R.A. was developing a unit which gave promise of excellent performance and maintenance. The B.C.U.R.A. stated that a review of existing designs of portable producers had shown that their possibilities were fully exploited and therefore they had started afresh and designed a completely new unit which is now patented. In this connection, standard text-books printed over thirty years ago disclosed that the ordinary cross and up-draught producer—or variations of them—had altered little, if any, from the original designs of stationary producers, and that one great drawback, common to all, was lack of flexibility when coupled to a road engine with its infinite variations due to load, revolutions and gradient. The tuyère type of producer inevitably suffers from the localised heat zone created by the tuyère, with consequent restriction of a gas "reserve"—hence lack of flexibility.

Skilled research had also been devoted to filtering and fuel problems. Thus it can probably be stated that the B.C.U.R.A. unit was the first one specifically designed to suit the fuel and the road engine. The filter was designed to work with the fuel and producer.

Experience with the B.C.U.R.A. Central-Draught Producer, Wet Blast

A unit of this type, which is a low-velocity central draught, with several interesting features, was purchased and installed on the first Morris vehicle in November, 1941. The importance of the research work spent on this unit is shown by the facts that tar was avoided by using a high-temperature coke with a low ash and tar content and activating with alkali; that really efficient filtration was for the first time forthcoming when used with a regulated wet injection; that flexibility was pronounced under all conditions and that tar deposits corroded pipes and choked manifolds had become a thing of the past. After nearly 15,000 miles' service with one unit and well over 6000 with the C. and W. coupled to the I.C.I./B.C.U.R.A. filter no manifolds or ports have had to be cleaned, although previously manifolds and ports had to be cleaned every 2000 to 5000 miles, no pipes renewed, plug life increased and plug trouble minimised. The latter, in fact, except when the vehicle is left in the open overnight in cold or wet weather, does not now cause anxiety, although producer gas is more severe on plugs than petrol. It is now possible to run 1000 miles without cleaning plugs. Several early difficulties, due primarily to the fact that this unit was not yet out of the experimental stage, were satisfactorily disposed of, in some cases by the inventors, in others by devices of our own.

Table I.—*Devonshire Journeys*

Vehicle.	Apparatus.	Miles.	Fuel, lb. per mile.	Petrol, m.p.g.	Total weight carried, tons.	Average speed, m.p.h.	Average load. Out, tons.	Average load. In, tons.	No. of journeys.
C.T.C. 541 ...	B.V.P./C. and W. ...	12,127	1·18	34·5	126¼	17·3	3½	1½	23
C.T.C. 541 ...	B.C.U.R.A. prior to 17.3.42	525	1·27	21·0	7	15·8	4½	2½	1
C.T.C. 541 ...	B.C.U.R.A. after 17.3.42	3,040	1·42	66·1	34½	18·5	4½	1¾	6
C.T.C. 542 ...	C. and W.	13,512	1·19	30·8	138	17·1	3¾	1½	26
C.T.C. 542 ...	C. and W./B.C.U.R.A.	505	1·16	56·1	6¾	16·1	4½	2¾	1
E.T.E. 38 ...	Albion, petrol	N.B.—Gross laden weight 4,138	—	13·3	with 4½ 42½	tons pay 20·6	load, 8 to 3¾	ns 1½	8
C.T.C. 541 ...	B.C.U.R.A., 16.6.42 ...	N.B.—Gross laden weight 505	1·20	101·0	with 3¾ 5¼	tons pay 19·8	load, 6¾ 4½	tons ¾	1
E.T.E. 38 ...	Albion, 28.5.41	547	—	13·7	(Best 6¼	performance on 21·4	gas) 3¾	2¾	1
					(Best	performance on	petrol)		

Notes.—(1) The normal number of stops for meals, rest, loading, &c., on these runs is twelve in three days.
(2) The Albion has a four-cylinder engine, 3⅜in. bore by 5½in. stroke, capacity approximately 3876 c.c.

Alterations or Improvements to Producers

Quite apart from a very great deal of experimental work done to the earlier units, most of which was swept away by the introduction of the B.C.U.R.A. equipment, a few further modifications, principally to the controls, have been introduced by my company.

A by-pass starting device to ensure lighting of the producer whilst keeping engine revolutions down to normal "tick-over" speed has been developed and is quite satisfactory. The air spoil draught to the water carburetter has been re-designed to give a more positive control.

The change-over valve, which necessitates only one foot accelerator, has been re-

designed to avoid seizure, and this is quite successful.

In the case of the altered C. and W. unit, which has retained the tuyère, the latter has been re-designed and after 6000 miles was still in service. It has given no trouble. A flame-proof trap to the tuyère intake has also been fitted. This unit, however, is shortly to be supplanted by a second B.C.U.R.A. producer. Many improvements of this nature have been incorporated as standard in the latest B.C.U.R.A./Vauxhall models.

Engine Wear

Contrary to general opinion, it is believed that most wear is due to excessive engine revolutions, either to start the producer or in intermediate gears. The former has been cured by introducing the by-pass starting valve and the latter has been greatly reduced by the constant high quality gas produced by the B.C.U.R.A. unit. Upper cylinder lubrication has been used from the commencement in March, 1940. Experience is shown in Table II.

Table II.—*Engine Wear*

B.V.P.	First engine	512 miles after 74,143 miles on petrol	Cracked block due to frost
B.V.P.	Second engine ...	4759 miles: Wear 2030 miles per 0·001in.	
C. and W./B.V.P.	Second engine ...	15,527 miles: New rings, 11,562 miles	
C. and W./B.V.P.	Third engine... ...	9635 miles: Wear 2400 miles per 0·001in.	This engine has had many gruelling tests in severe weather
B.C.U.R.A. ...	Third engine... ...	14,805 miles: Wear 2112 miles per 0·001in.	
C. and W.	First engine	18,202 miles after 83,000 miles on petrol... ...	Wear 2000 miles per 0·001in.
C. and W.	Second engine	15,408 miles	Wear 2569 miles per 0·001in.
C. and W./B.C.U. R.A.	Second engine (rebored)	6153 miles in service	—

Sump oil analyses show that with an efficient filter, such as the I.C.I./B.C.U.R.A., the only deposits in the sump in the early stages were traces of the alkalis in the gas, following activation of the fuel. Improvements in filter design have eliminated these and the results are now practically indistinguishable from a petrol vehicle sump oil analysis. The first sump oil analysis two years ago was positively frightening.

Filter

Early experience has already been mentioned. Experience of 20,000 miles shows that the I.C.I./B.C.U.R.A. unit is an extremely efficient one. In its latest form a very high mileage can be accomplished with the safeguard that the filter will choke before it can pass over any foreign matter. A vacuum gauge in the cab warns the driver before his filter reaches the completely choked stage. A filter element can be replaced on the road in a few minutes. Filter life is naturally reduced if tarry fuels are used for which the filter was not designed, but even so, its efficiency remains unimpaired.

Operating Experience

Two out of seven vehicles have been converted to gas. These two gas producer vehicles in two years have accomplished 34 per cent. of the company's total vehicle mileage, carried 25 per cent. of the total tonnage, run over 60 per cent. of the normal long-distance mileage, and nearly 90 per cent. of all journeys of 500 miles or over. A normal weight as carried by petrol is the load. Table I gives a detailed analysis of the 500-mile journeys with some petrol comparisons.

Reliability

The two gas producer vehicles were in service from April to September, 1940, respectively and, deducting time laid up due to subsequent conversions, engine renewals, and repairs, they have each averaged over 2000 miles per month. Reliability of the early types was not good, although no records were kept, but the figures for the B.C.U.R.A. unit are shown in Table III.

Table III.—*Experience with B.C.U.R.A. Producer*

	Days.	Per cent.	
Total available running days	175	—	
Time actually running...	138	79·0	Averaging 107 miles per day
Repairs to body, chassis, springs, &c., other than producer gas	9	5·1	
Experimental work on gas	3	1·7	
Alterations, including devices of own design	15	8·5	Including waiting for material
Gas service other than in normal hours	8	4·6	Chiefly overcoming difficulties
Repairs to producer	2	1·1	with change-over valve
Engine repairs, nil.	175	100	
Some of these items are non-recurring.			Mileage 14,805.

These two vehicles have now performed 439 journeys, of which fifty-seven were of three days' or longer duration and 200 of two days' duration. The fifty-seven journeys represented 29,709 miles, the 200 represented 40,903 miles, and of these the B.C.U.R.A. has accomplished 3565 miles with runs of 500 miles or over, and 10,433 miles with runs of 200 miles or over. The total mileage run is 85,001, and tonnage hauled 2644.

Petrol Savings

Table II shows the summarised results of the saving in petrol since using producer gas. Allowing for experiments, running-in engines on petrol, and test runs, the gross saving over two years is over 6000 gallons. This means that 57,000 miles have been run for which petrol might not have been forthcoming. Petrol savings by themselves are not the only criterion, but when increased savings are accompanied by a higher average speed, longer filter life, increased filter efficiency, and greater reliability, the improvement brought about by the I.C.I./B.C.U.R.A./Vauxhall design is most apparent. The

Table IV.—*Performance of Producer Gas Vehicles*

Equipment.	Period.	Mileage.	Fuel, lb. per mile.	Petrol. Inclus., m.p.g.	Petrol. M.p.g.*	Seped, m.p.h.	Weight carried, tons.	No. of journeys.	Filter life, miles.
Vehicle C.T.C. 541									
B.V.P. ...	March/Sept., 1940 ...	5,271	0·94	40·8 approx.	42·1 approx.	Not known	270	63	100/200
B.V.P./C. & W.	Sept., 1940/Sept., 1941	25,162	1·29	26·5	28·0	Not known	707	115	500
B.C.U.R.A...	Nov., 1941/March, 1942	7,370	1·20	20·6	21·7	17·0	267	42	660‖
B.C.U.R.A...	March/May, 1942 ...	5,383	1·44	39·8	41·4	17·4	129½	20	1000‖
B.C.U.R.A...	May/June, 1942... ...	2,052	1·47† / 1·35‡	50·0† / 53·3‡	50·0† / 53·3‡	18·6† / 19·0‡	61	9	1420‖
		45,238					1434½	249	
Vehicle C.T.C. 542									
C. and W. ...	Sept., 1940/Dec., 1941	33,610	1·23	27·2	28·3	Not known	988½	158	500
C. & W. with I.C.I./B.C. U.R.A. filter	April/May, 1942 ...	2,305	1·49	18·1	35·1	16·6	91½	14	400
	May/July, 1942 ...	3,848	1·38	43·5	43·5	16·7	129½	18	1190‖
		39,763					1209½	190	

* This column is exclusive of all experimental or test runs, running-in engines on petrol, &c. † Including Government anthracite. ‡ Excluding Government anthracite. ‖ With efficient filtration.

			Gallons.
Total mileage, C.T.C. 541 ...	45,238	Normal petrol consumption...	8947
C.T.C. 542 ...	39,763	Inclusive actual consumption	3069
	85,001	Saving, net	5878
		Add petrol used on experimental, &c.... ...	181
		Saving, gross	6059

Petrol Consumption Data

	C.T.C. 541. B.V.P.	C.T.C. 541. C. and W./B.V.P.	C.T.C. 541. B.C.U.R.A.	C.T.C. 542. C. and W.	C.T.C. 542. C. and W./B.C.U.R.A.
Number of service runs exceeding 100 m.p.g. ...	—	1	1	4	3
Number of service runs exceeding 80 m.p.g. ...	—	1	2	1	—
Number of service runs exceeding 70 m.p.g. ...	—	1	1	—	—
Number of service runs exceeding 60 m.p.g. ...	3	3	6	5	6
Number of service runs exceeding 50 m.p.g. ...	2	2	10	10	6
Total mileage	5,271	25,162	14,805	33,610	6,153
Percentage of these runs to total vehicle runs ...	8	7	28	12¼	47

Note 1.—If allowance is made for the initial running-in period of the B.C.U.R.A. appliance on vehicle C.T.C. 541, the percentage of low petrol consumption runs would be 50. All experimental work has been done on vehicle C.T.C. 541. Vehicle C.T.C. 542 accordingly has benefited. Observe, however, the lower average speed with C.T.C. 542.

Note 2.—Vehicle C.T.C. 542 is shortly to be equipped with a B.C.U.R.A. producer, thus making it comparable to C.T.C. 541, except that the latter has a horizontal filter, whilst the former is vertical—the only instance, it is believed, of the I.C.I./B.C.U.R.A. filter installed in this manner.

Note 3.—These two vehicles are large-capacity box vans with a high wind resistance and a high centre of gravity, which are not conducive to exceptionally fast runs, whether on petrol or gas. Maximum pay loads are carried.

B.C.U.R.A. units are now saving petrol at the rate of nearly 2000 gallons per vehicle per year, an improvement of 30 per cent. This improvement is also detailed in Table IV, and the higher proportion of runs giving a consumption of 50 miles per gallon or more is noteworthy. It is expected that the improvement will continue, as although purely experimental work has been deducted in arriving at the above figures, it will be appreciated that up to date practically the whole of the runs, although actual service runs, have been devoted to development. That is to say, in nearly every run the effect of some device, improvement, or change of fuel has been observed and recorded, petrol savings being a secondary consideration. The savings depend on the mileage run, and owing to restrictions on manufacturers and changes in sources of supply, it is not anticipated that an annual mileage per vehicle of 25,000 can be greatly exceeded, and therefore a saving of 2000 gallons, or somewhat more, on this figure is probably nearly the commercial limit.

TABLE V.—*Experiments with Different Fuels*

Unit.	Mileage.	Lb. fuel used.	Type of fuel.
B.V.P. cross-draught	5,271	2,396	Suncole
		1,395	Progasite
		1,109	Sundry
B.V.P./C. and W. up-draught	25,162	444	Suncole
		10,985	Progasite
		19,898	Coalite
		1,240	Rexco
B.C.U.R.A. central-draught	14,805	13,438	Activated coke
		5,229	Rexco
		30	Sundry
		792*	Activated progasite
C. and W. up-draught	33,610	1,351	Suncole
		14,007	Progasite
		21,429	Coalite
		5,490	Rexco
		126	Activated coke
Adapted C. and W. annular-draught with I.C.I./B.C.U.R.A. filter	6,153	7,265	Activated coke
		120	Rexco
		328*	Activated progasite

* At Government request.

Fuel

Experiments were constantly made in the use of fuel. A summary is given in Table V.

We have now standardised on activated high-temperature coke. It is found that this fuel is very clean, deliveries do not appear to vary to any extent, and it gives gas of a constant high quality. The improvement in general performance when running on this fuel is marked. At the request of the Government we are running the B.C.U.R.A. appliance with activated progasite and ordinary progasite for a short period. The results so far, however, are not as good as those obtained with activated coke.

Later Results

Recent results of the B.C.U.R.A. unit after preliminary troubles were rectified show a very great improvement in performance. In fact, it will be seen that with a higher gross loading than a petrol engine on the same long-distance run, the average speed maintained was about 10 per cent. less than the petrol performance. When consideration is given to the fact that the engine is a standard unit, with standard compression, it is felt that little further improvement can be expected without engine development. When fully on gas, driving with the B.C.U.R.A. unit is very similar to driving a petrol vehicle. Response to the accelerator is notable. The 10 per cent. lower speed referred to means a difference of 2½ hours' driving time in three days—a negligible amount, as the legal hours are complied with with a useful margin in hand.

Development

As the B.C.U.R.A. unit represents, in our opinion, the first real effort to break away from the Continental designs based on charcoal fuel to a British design based on home-produced fuel and has been attended by such promising results, it is reasonable to suppose that even better performance can be obtained in the future.

It must be remembered that the excellent results referred to, and shown in summary beneath, have been achieved by a standard petrol unit without modification and with equipment which, owing to war conditions, has not always been manufactured from the most suitable and enduring material. It is logical to assume, therefore, that when a power unit designed to run on producer gas primarily—just as the B.C.U.R.A. unit was designed to comply with specified fuels—is developed without the hindrance of substitute materials and other compromises, performance should in time equal petrol.

Analysis of Two Years' Experience

Experience with gas producers over two years, filled with trials, troubles, and difficulties, conclusively proves that only when a successful design was forthcoming which broke clearly away from the influence of the Continental charcoal producers was real progress made. Until then attempts to remedy lack of flexibility and response, presence of tar and corrosion and heavy maintenance were, as far as touching the core of the problems is concerned, fruitless. Any apparent success was either temporary or superficial. At present the three outstanding advances in the solution of practical gas production applied to road transport are the selection of the right fuel and extraction of tar at the source, the invention of a suitable and extremely efficient filter, and the development of a producer which gives high-quality gas combined with almost petrol "response." These three factors are interdependent and related and the previous lack of appreciation of this most important truth has been the major cause of unsatisfactory progress in producer gas applied to road transport. Journeys of anything up to 500 miles, or even over that distance, are now undertaken with producer gas as a matter of routine, just as in the case of a petrol-driven vehicle, without the slightest necessity for special servicing and preparation beforehand. All that is necessary is to take a spare filter element in case it may be needed, and to perform routine cleaning of the units.

Conclusion

In the light of the information given in this article, all derived from actual service experience, bearing in mind similar results obtained by other firms using B.C.U.R.A. units (to which access has kindly been given), it is difficult to understand the Government's persistence in continuing to sponsor emergency cross-draught producers (in essence based on charcoal fuel design) and anthracite fuel. Supplies of the latter, it is understood, are in any event insufficient to cater for the running of such producers on a national basis, even if that is the reason for adhering to an obsolete design.

Boilers—Past and Present*

By Colonel S. J. THOMPSON, D.S.O., M.I. Mech. E.

No. III—*(Continued from page 378, November 6th)*

Standardisation

WHILST fully aware of, and in agreement with, the continued development of power plant research, experience over the last few years has led me to advocate strongly the necessity for the standardisation of all power station boiler installations. A few stations could be selected for research and development of higher steam pressures and temperatures, &c. There appears to have been a tendency in the past for engineers to compete with one another in steam pressure, superheat, and ancillary plant. This rivalry has, of course, increased the cost of installation. Furthermore, the capacity of steam plants appears to vary considerably, and very little attempt is made to use standard units. This practice necessitates the employment of an excessive number of design staff, draughtsmen, &c., and the preparation of a large number of special drawings, all of which could be curtailed if certain standards were generally adopted.

I would suggest that, say, three or four heat cycles should be considered with a view to standardising steam pressures, steam temperatures, and feed water and air temperatures, the sizes of boiler units also being considered as far as possible. For example, the following four ranges (Table I) might receive consideration :—

TABLE I.—*Suggested Standard Conditions for Power Station Boilers*

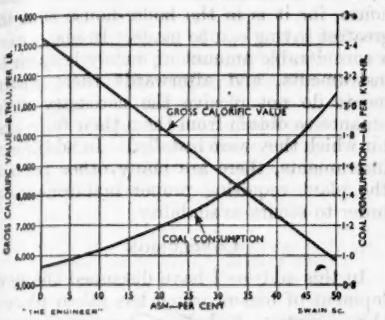
Class.	Pressure, lb. per square inch.	Steam temperature, deg. Fah.	Feed water temperature, deg. Fah.	Air temperature, deg. Fah.
(*a*)	250	750	220	275–300
(*b*)	425	825	260	,,
(*c*)	650	825	300	,,
(*d*)	850	900	350	,,

When pulverised fuel is adopted instead of mechanical stoker firing, the air temperature may be in the region of, say, 500 deg. Fah. As regards the capacity of units, considera

* Institution of Mechanical Engineers, October 23rd, 1942: Presidential Address. Abstract.

tion might be given to 100,000 lb., 150,000 lb., 200,000 lb., and 250,000 lb. of steam per hour.

Even if only a limited amount of standardisation could be arranged, I feel sure that it will remove many of the manufacturers' difficulties, and will assist in effecting early completion of boiler plant.



The chart shows that with 10 per cent. ash, for example, the gross calorific value is 11,760 B.Th.U. per lb. and the coal consumption is 1·036 per kWh. Similarly, with 30 per cent. ash the corresponding figures are 8820 B.Th.U. per lb. and 1·382 lb. per kWh. The gross calorific value of the coal, as dried, is taken as 14,700 B.Th.U. per lb. and the moisture content as 10 per cent.

FIG. 16—EFFECT OF ASH CONTENT OF COAL.

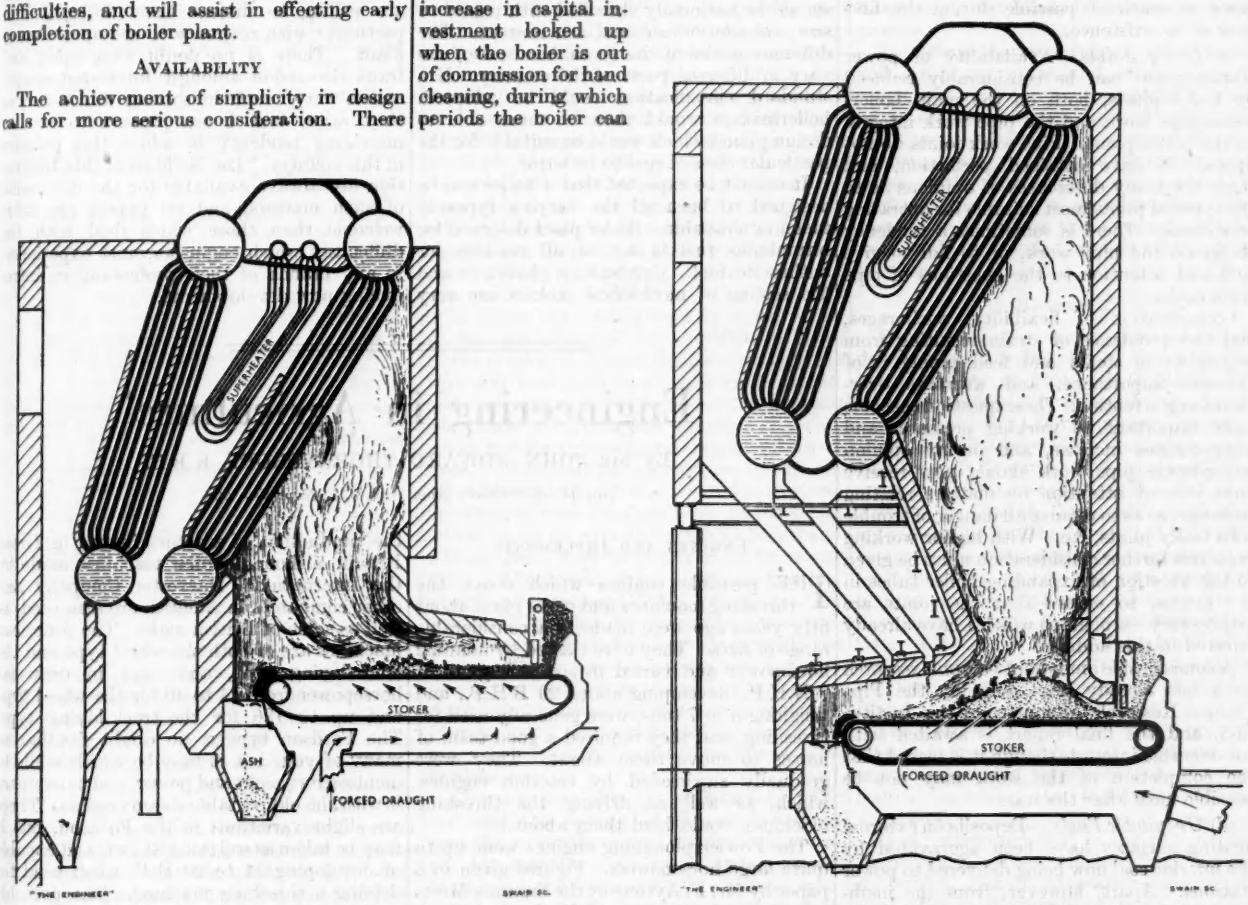
AVAILABILITY

The achievement of simplicity in design calls for more serious consideration. There appears to be a tendency to embody too many "frills," which in a number of cases not only increase the capital cost of the plant, but invariably increase the operating engineer's troubles, and at times necessitate the shutting down of the complete boiler plant, as a result of these minor troubles. During that time large capital investment is standing idle.

It is very interesting to note that at the present time considerable importance is being attached to securing an increase in what is termed "boiler availability," even at the expense of some of the thermal efficiency of the plant. High thermal efficiency must be considered in relation to "dollar" efficiency. It must be appreciated that, in designing boiler plant for very high efficiencies—say, 87 to 89 per cent. (based on the gross calorific value of the fuel)—low exit gas temperatures are necessary. From such low temperatures corrosion may arise, also deposits in the air heaters, which may cause the plant to be shut down and may thereby reduce the availability period of the boiler plant. It thus appears to be more important to install a plant in which, by permitting a little lower efficiency, the availability period is considerably increased and the cost of maintenance reduced to a minimum.

It is recognised that the availability of turbo-alternators is much higher than that of boiler plant. Six months' continuous service is generally the maximum boiler availability which can be maintained at the present time without hand cleaning—some boilers do not remain in service more than a few weeks—whereas a generating set will remain on the line for periods of twelve months or more.

Another point to be taken into consideration in connection with the availability of large boilers is the increase in capital investment locked up when the boiler is out of commission for hand cleaning, during which periods the boiler can be looked upon as a liability rather than an asset.



FIGS. 17 AND 18—WATER-TUBE BOILER FURNACE SETTINGS FOR BITUMINOUS AND ANTHRACITE FUELS

Reduced availability can be due to the following main reasons :—

(*a*) Deposits on external heating surfaces.
(*b*) Conditions arising from the use of unsatisfactory water.
(*c*) Leaky joints, particularly with high pressures.
(*d*) Unsuitable fuels.
(*e*) Inadequate maintenance staff.

(*a*) *Deposits on External Heating Surfaces.*—I think I am right in saying that one of the most troublesome factors affecting availability is the difficulty of maintaining external cleanliness of the heating surfaces. During the past ten years increasing difficulty has been experienced due to the formation of external deposits on the heating surfaces of boilers, superheaters, economisers, and air heaters. This necessitates the frequent laying-off of plant for the purpose of forcibly removing these deposits. In many instances it is impossible to keep units continuously on the line for more than three or four weeks. So serious has this problem become that a Boiler Availability Committee has been formed to investigate these problems, with particular reference to external deposits and corrosion, and to discover means for their elimination. This Committee, comprising representatives of the Central Electricity Board, power station engineers, various boilermakers, and the British Coal Utilisation Research Association, has already recommended, as a short-term policy, the application of a particular form of water lancing, which shows promising results in the removal of external deposits, particularly from superheaters. Investigations are still in progress and much work both in the field and in the laboratory has been planned, to be carried out through this Committee. The co-operation shown by the users and manufacturers of boiler plant is a healthy sign, and the future work of this Committee should prove to be of immense value to the national effort.

(*b*) *Water Conditions.*—To maintain efficiency and availability, it is imperative to keep the boiler heating surfaces clean internally. Internal cleanliness depends entirely upon the water used, and while the necessity for correct water treatment is now recognised by most power station engineers

as essential, there are still some cases where unsuitable water is being used.

With the increased pressure and rate of evaporation, water treatment becomes even more important, and at large power stations skilled chemists should be available to deal with water and other chemical problems. Here, however, a word of caution will not be amiss. After a period of service under suitable conditions the internal surface of a boiler will develop a protective skin or coating; but during the early days of the boiler's life the unprotected steel is susceptible to attack by corrosive elements which may occasionally occur in the presence of otherwise absolutely pure water. I have seen several cases recently where new boilers have been severely attacked by internal corrosion in the first few months of their life, whilst existing boilers in the same station show no defects from the use of the same feed water. This has undoubtedly been due to the protective skin, which was present in the old boilers but absent in the new, and I would advise all power station chemists to consider seriously giving special attention to new plant, particularly avoiding the opening up and exposure of the plant to atmospheric gases as much as possible during the first year of its existence.

(c) *Leaky Joints.*—Availability of power station plant can be considerably reduced by leaky joints, both on the main boiler-house pipe work and the pipe work integral to the boiler plant. Pipe work joints do not appear to have attained perfection, and there are many differences of opinions as to the types of joints most suitable for operating conditions. There is sometimes a tendency to ignore the pipe work, or to fail to give sufficient attention to the questions of pipe work design.

Consideration of flexibility, anchorages, and the avoidance of strain resulting from expansion in steam and feed piping is of extreme importance, and warrants ever-increasing attention. These questions become more important as working pressures and temperatures increase, and in my opinion boiler-house pipe work should now receive most earnest attention on matters relating to design, so as to remove all danger of trouble with leaky joints, &c. With higher working pressures further consideration must be given to the question of expanding boiler tubes in the drums, to ensure that the joints are satisfactory—a point to which I have already referred in this address.

A considerable amount of valuable research work has already been done by the Pipe Flanges Research Committee of this Institution, and the final report is awaited with considerable interest, though it is feared that the completion of the work may not be possible until after the war.

(d) *Unsuitable Fuels.*—Deposits on external heating surfaces have been aggravated by the inferior coal now being delivered to power stations. Apart, however, from the inefficiency and poor availability caused by inferior fuels, there never was a time when it was so necessary for transport to be reduced to the minimum. With the lower grades of fuel less heat units per ton are being transported from the pits, a state of affairs which involves unnecessary additional transport. This adds many extra trucks to every trainload, these extra trucks representing the higher percentage of ash and water content in the inferior fuels. The additional tonnage thus carried does not give one extra kilowatt of power in return. Moreover, the poor fuel increases the maintenance costs and puts additional load and cost on the coal and ash-handling plants at the power station itself. In addition, there is extra ash to be disposed of, which again means additional transport and extra cost.

The use of certain inferior types of fuel on boilers which have been designed for normal types of fuel usually means that the output of each boiler is reduced, in some cases by as much as 25 to 30 per cent. below normal. This often means that four boilers have to be in operation when burning inferior fuel to give the output which, with a good coal, could have been obtained with three boilers.

One must appreciate the present difficulties of the Ministry of Mines and the difficulties of giving consumers the type of fuel they normally use. Nevertheless, a number of people connected with power stations feel that more consideration should be given to the production and transportation of better and cleaner fuels from the mines to the power stations, which, in my opinion, are the most important consumers of fuel in the country. Fig. 16 clearly indicates, in addition to the transport and handling of the ash, how the fuel quality affects the number of heat units obtained per pound of coal, and shows the loss of power generated per ton of inferior coal used.

The time has now been reached when coals should be nationally classified with regard to size, volatile matter, and ash content. The different grades of size (peas, beans, &c.) can vary in different parts of the country. If a standard classification could be adopted, boilermakers would then be more able to design plants which would be suitable for the particular class of coal to be burnt.

It cannot be expected that a boiler can be designed to burn all the varying types of fuel now available. Boiler plant designed for bituminous fuel is not at all suitable for anthracite fuel. Combustion chambers and the setting of mechanical stokers are very different, according to the class of fuel burned (Figs. 17 and 18).

(e) *Inadequate Maintenance Staff.*—It would appear that too little attention has been given to the necessity for a suitable and efficient maintenance staff in the boiler-house, for it is in the boiler-house that the greatest saving can be made. In many cases a considerable amount of money is spent on instruments, and afterwards these instruments do not receive the necessary maintenance to obtain from them their full value, for which they were installed. In addition to instruments, there are many other parts of the plant requiring proper maintenance in order to secure availability.

Conclusion

In this address I have discussed the development of boilers which has taken place in this country, including, however, certain types and developments which have had their origin abroad. In this connection I would like to acknowledge the debt we owe to the researches and developments which have taken place in America, particularly in regard to large and high-pressure boilers. We have benefited by the open way in which Americans are willing to discuss their difficulties in particular with reference to the operation of plant. There is no doubt that open and frank discussion amongst interested people assists very much in solving difficulties as they arise, and I am pleased to see an increasing tendency to adopt this practice in this country. The facilities of this Institution are always available for the discussion of such matters, and no papers are more welcome than those which deal with the difficulties which engineers must experience, in any branch of their profession, in introducing new developments.

Engineering in Agriculture*

By Sir JOHN EDWARD THORNYCROFT, K.B.E.

No. II—(*Continued from page 375, November 6th*)

Engines and Implements

THE portable engines which drove the threshing machines and other plant about fifty years ago were made in a considerable range of sizes. They were classed by nominal horsepower and varied in size. Engines of 7 N.H.P., developing about 20 B.H.P., and weighing 6 to 7 tons, were generally used for threshing, and they required a good team of horses to move them about. They were gradually superseded by traction engines, which, as well as driving the threshing machines, could haul them about.

The Fowler ploughing engines went up to quite large horsepowers. Figures given in a paper by Mr. F. Ayton† at the Summer Meeting of the Institution of Mechanical Engineers in June, 1926, in connection with them, were as follows :—

	Per 8-hour day, acres.
Horse plough, with single-furrow plough, two horses in light land and three in heavy	1
Steam, double-engine set—	
75 I.H.P., or equivalent oil engines	10–12
100 I.H.P., or equivalent oil engines	16–18
135 I.H.P., or equivalent oil engines	20–23
200 I.H.P., or equivalent oil engines	30–34
250 I.H.P., or equivalent oil engines	32–40

Of the wheel type of tractor, that introduced by Ford represents the major part of the production of tractors in use in Great Britain, although similar machines made by the International Harvester Company and other companies in America are also used, as well as some of British make. The American machines are of both the wheel type and the track-laying type, and vary in draw-bar horsepower from 24 to 40 for the wheel type and up to 126 for the track-laying type. The Fordson type is no doubt familiar to many of you, but it may be worth while to mention its weight and power, and to compare it with the old portable steam engines. There are slight variations in the Fordson, but it may be taken as weighing 31 cwt. and capable of developing 14 to 20 H.P. when used for driving a threshing machine. The portable engine which drove a similar threshing machine and developed approximately the same power weighed 4 tons, but it was not entirely self-contained, and required the service of water carts and coal carts.

The great advantage of the internal combustion engined tractor is that it is capable not only of performing the work of the old portable steam engine, but also of hauling ploughs and the various tillage implements for which it was primarily designed. Performance data, kindly supplied by Sir Patrick Hennessy, are given in Table I.

The track-laying tractors of the caterpillar and similar types, which now are used to haul large multi-furrow ploughs, are usually fitted with diesel engines developing

* Institution of Civil Engineers: Presidential Address, November 3rd. Abstract.

† "Applications of Engineering to Agriculture," "Proceedings," Inst. Mech. E. 1926 (II), page 683.

up to 55 H.P. They are being produced in very large numbers in America. The heaviest of them used in agriculture weigh up to 11 tons, but with their tracks the intensity of load is so limited (7 lb. per square inch) that there is seldom ground on which they cannot operate.

It is instructive to compare the fuel consumption of the present-day tractors with that of the steam engines formerly used to do the same sort of work. The coal consumption per brake horsepower of portable engines used for threshing was about 3 lb. per hour. Slight variations existed between the single-cylinder and the compound engines, and in the Royal Agricultural Society's competitions different makers strove very hard to gain fractions of a pound. The consumption of vaporising oil by a tractor to-day, doing either threshing, which is directly comparable with the portable steam engine, or ploughing, is about 0·7 lb. per B.H.P. per hour. The quantity of coal used for farm work now is negligible in comparison with that used for other purposes, but the quantity of oil consumed by tractors is becoming quite important. Considering the vaporising oil and neglecting the petrol used for starting up and the diesel oil consumed by the limited number of tractors that require it, the consumption was relatively unimportant a few years ago. But with the rapid increase in the number of tractors, and the much greater quantity of work that is now obtained out of them, the consumption of vaporising oil represents a considerable portion of the country's petroleum imports. The necessity for using this large quantity of oil to the best advantage, and wasting none of it, is obvious. It is unlikely that anything material can be done to improve the efficiency of the motors, but their users can do something to prevent waste.

TABLE I

Number of Man-Hours Required To-day to Plough, Prepare, and Harvest 10 Acres of Wheat

Operation.	Tractor man-hours.	Horse man-hours.
Ploughing (2-furrow) ...	30	80 (2 horses)
Disc harrowing	5 (tandem disc)	26 (single tandem twice)
Drilling	20 (2 men)	20 (3 horses and 2 men)
Harrowing	3	5 (1 horse)
Artificial manure distributing	9	6 (1 horse)
Harrowing	3	5 (1 horse)
Rolling	3	5 (1 horse)
Harrowing	3	5 (1 horse)
Rolling	3	5 (1 horse)
Harvesting with binder	10 (2 men)	20 (3 horses and 2 men)
Total	89 hours	177 hours

Fuel Costs per Acre

The following figures have been calculated over a lengthy period of time and varying conditions :—

	Gallons per acre.
Ploughing (with 2-furrow plough) ...	3·43
Discing	0·55
Harrowing	0·27
Rolling	0·37
Drilling	0·84
Cultivating	1·1
Ridging	1·0
Mowing	1·1
Combine harvesting	0·88
Artificial manure application	0·37
Total	9·91

Therefore the fuel required for raising an acre of wheat will work out as below :—

	Gallons per acre.
1 Ploughing (2-furrow plough)	3·43
1 Disc harrowing	0·55
1 Drilling	0·84
1 Harrowing	0·27
1 Artificial manure application	0·37
1 Harrowing	0·27
1 Rolling	0·37
1 Harrowing	0·27
1 Rolling	0·37
1 Combine harvesting	0·88
Total	7·62

With the land drained, one comes to the tillage of the soil. Light and heavy soils, of course, require very different quantities of power to cultivate them, and formerly it was customary to speak of two-horse and three-horse land. A good deal of controversy has arisen recently about the number of furrows with which a wheeled tractor can deal. In the great majority of cases it seems to be generally conceded that a three-furrow plough is not overloading it. A tractor with a three-furrow plough operated by one man can more than do the work of three ploughmen and six horses, and the track-laying type of tractor with a four-furrow or six-furrow plough more than the work of five men and ten horses.

It has been pointed out that with horse tillage it was not possible to couple a series of different implements behind one another ; but with tractors this can be done, and in some cases a seed bed can be prepared in one operation when ploughing. There is an especial advantage in this. When the work could be carried out only at the low speed resulting from the several operations, it was necessary that the land should be in the right condition each time, and, owing to our climate, the conditions often varied very rapidly, with the result that when the farmer had only a limited number of horses and men, delays occurred in waiting for them and for the soil condition to change. With the possibility of the preparation of the land for the seed bed being carried out much more rapidly, advantage can be taken of doing the work quickly while the soil condition is most suitable, and there can be no doubt that this has contributed very greatly to the speed with which land has been successfully broken up and seeded during the past year or two.

Sowing

Machines for sowing seed in drills, which in essential features were similar to those of the present day, were designed many years ago, and were used to a considerable extent, although many farmers preferred to broadcast their seed into the ploughed furrows, which had been pressed, and then harrow them over. Broadcasting of seed required considerable skill when it was desired to sow predetermined quantities per acre, and the drill which could do so with certainty had many advantages. Very little corn is grown nowadays without employing artificial manure, at any rate in Great Britain, and the modern seed drill, which also distributes an appropriate quantity of fertiliser along with the seed, not only saves one operation, but also places the fertiliser in the soil in the immediate neighbourhood in which it is required. It must certainly be regarded as one of the most important of recent developments in implements.

I cannot pass over the cultivation of the soil and the sowing of the seed without referring to modern developments in machinery for planting root crops and potatoes. Machines have been devised, which in some cases are partially hand operated and in others are entirely automatic. The ingenuity shown in their design is very great, and the time saved is most remarkable.

With the limitation in man power, hoeing, an essential operation in connection with row crops, has presented a difficult problem, but the designers of tractors and implements have met it with the production of special row crop tractors and hoes for dealing with the ordinary root, sugar beet, and similar crops.

Harvesting

With regard to the harvesting of crops, the importance of the reaper and binder has already been mentioned. By employing it, two men can now do the work which could be done by ten men when the corn was cut with a scythe. Whilst there may be limits to its application in Great Britain, the combine which reaps and threshes in one operation can reduce the man-hours to obtain a sack of corn in the ratio of 1 to 17.

In his work, "Farm Machinery and Equipment," Mr. Harris Pearson Smith, Chief of the Division of Agricultural Engineering, Texas Agricultural Experiment Station, makes the following statement :—

"The effect of the mechanisation of agriculture is shown in the number of man-hours required to grow and harvest an acre of wheat yielding 20 bushels. In 1830, when the grain was sown by hand and harvested by hand with a cradle,‡ 55·7 man-hours were required. In 1896, with the use of the horse-drawn drill and binder, it took 8·6 man-hours ; while in 1930, with the tractor-drawn drills and combine, it required only 3·3 man-hours."

But besides these developments in the harvesting of corn crops, much has been done to reduce the quantity of labour necessary in lifting such crops as sugar beet by the employment of special ploughs, whilst other machines have been introduced for pulling flax, which, by hand, is necessarily a slow process.

To reduce the labour involved in cutting and collecting grass and other crops for silage, and grass for drying, special machines have been devised to cut and collect it, which effect great economies. The recent development in drying young grass for fodder, which possesses the nutritive value of the best concentrated foods, is a problem which engineers have solved, to the great advantage of milk production and of farmers who are stock-breeders.

Research

Recognising the importance of further development, the Ministry of Agriculture and the Secretary of State for Scotland have recently decided to establish an Agricultural Machinery Development Board, of which Lord Radnor is the Chairman, and an Institute of Research in Agricultural Engineering, which will take over the staff of the Faculty at Oxford University which dealt with the subject. The Director of the Oxford Institute has been appointed Director of the new Institute, which will be housed temporarily in the buildings belonging to the Yorkshire Council for Agricultural Education. Later, it is intended to build a permanent home for the Institute on a site near the temporary accommodation at Askham Bryan.

The Oxford Institute was primarily intended for research, and its Council at one time included representatives of various bodies, including the Institution of Civil Engineers.

It is understood that in the new national Engineering Institute emphasis will be placed on testing, and on adaptation on the practical side, as distinguished from the purely theoretical side. For the problems involving pure research in subjects underlying agriculture and engineering, the Institute will be called upon to aid the Agricultural Research Council of the Department of Scientific and Industrial Research, and its main functions will be to act as a general clearing-house for information about agricultural machinery and its uses, to carry out tests or demonstrations of new or improved implements, to undertake experimental and demonstration work on the better utilisation of existing

‡ This is the fitting on the stock or shaft of the scythe, adjacent to the end where the scythe blade is fixed, to enable the reaper, when he has cut enough to form a sheaf, to rake it together, ready for the woman sheaf-maker to bundle it.

equipment, and to fill the gap between inventor and manufacturer by putting new ideas into practical shape and arranging the construction of prototype machines.

Some may doubt the desirability of a Government Department undertaking design work, and may think it better that its functions should be limited to specifying requirements, it being left to the engineers of the implement-making firms to put forward their solutions of the problem, whilst the engineers and staff of the Agricultural Engineering Institute should carry out trials and decide which of the machines produced are the best, much in the same way that the Royal Agricultural Society dealt with similar problems in the past.

Sugar Beet

Although the growing of beet in the country for sugar may not be regarded as anything very different from the cultivation of other root crops, without the work of engineers in designing and providing the equipment for the sugar beet factories there would not have been the very large home-grown sugar industry which has been built up in the country in recent years. At the present time the British Sugar Corporation has contracts with more than 52,000 farmers, who provide 400,000 acres of the crop. Roughly, a fair crop should yield 10 tons to the acre, which should have a sugar content of at least 15 per cent. It has been stated recently by the agricultural authorities that the whole of the domestic sugar ration allowed in Great Britain at the present time is home-grown, and it is fortunate that, after the last war, in spite of considerable opposition to the development of home-grown sugar, the Government decided to foster the industry by means of special subsidies.

Electrical Power

So far as agriculture is concerned, the services of the electrical engineer have not been made use of in Great Britain to the same extent as they have in some other parts of the world. It is difficult to say how far the farmers themselves are to blame, or if the expense of the supply of electricity is the real trouble. The farmer who has made up his mind to utilise power to drive machinery at his homestead now usually installs some kind of internal combustion engine. Whilst his power may appear to cost him considerably less than he would have to pay for an electric supply, there can be no question that the various things that have to be done, in starting up his engine and keeping it in running condition, entail a considerable loss of time, which would be avoided if all he had to do were to start up an electric motor.

I think it can be said that electricity plays a negligible part in agriculture at the present time, and is confined to lighting the farm-houses when they are adjacent to local supplies. There are, of course, isolated cases where farmers have utilised electricity to drive all their plant, such as milking and dairy machinery, chaff-cutting, turnip slicing, &c.

It has been pointed out by Mr. Borlase C. Matthews, who has done much pioneer work at home and abroad, that a very considerable additional load might be obtained by the suppliers of electricity throughout the country if farmers generally utilised current in the same way that some of the pioneers have shown to be possible.

On the Continent of Europe considerable use has been made of electricity for cultivation, particularly in areas where sugar beet is grown and the supply of current is cheap enough to show an advantage over the internal combustion engine. There have been some developments in connection with cable ploughing, the winding engine carrying a drum from which the supply wires are paid out as the engine moves across the field. In some cases bare overhead conductors are installed, from which the implement picks up its current as it moves over the land to do its work.

A use of electricity which was rather a surprise to me, and may interest you, has been proved by Crowther and Haines at Rothamsted, namely, to reduce the draught of the plough by coupling it to a battery or generator, which will give the mould board a negative charge. In some soils the draught is materially reduced by the charge, causing moisture from the soil to be deposited on the plough breast by the effect of what is scientifically known as osmosis, thus lubricating the surface, with a consequent reduction in draught which may amount to one-third in favourable cases.

With the numerous high-tension transmission lines covering so much agricultural land, it would seem that it should be possible to provide current for farmers at a low price. It is difficult to understand how, in foreign countries, the supply companies have found it possible to do so when it is not done here. In some European countries, where a large percentage of the farmsteads have electric supplies, different rates are charged for lighting current and for power, the power charge being above the usual industrial rates, but quite reasonable.

If, on the purely economic basis of supplying electricity, the supply companies are unable to provide it at a reasonably low cost to the agricultural community and the farmer, I would suggest that the town dwellers and industrialists, who get their current at low prices, should be charged some overriding percentage, so that the supply companies would be able to distribute current to every agricultural holding at the same price at which the town dwellers get it. The postal and other national services are averaged to the users; the cost of electricity should be also.

To keep men working on the land, it is obviously necessary to make their living conditions as good as those of the town dwellers, and I suggest the first thing which should be done to improve them is to make electricity available to the villagers and to the farmers for whom they work.

The Scott Report on "Land Utilisation in Rural England" has dealt at some length with the importance of electricity being available to the farmer and in the villages. It states that the number of farmers in the country is 366,000, and that about 10 per cent. of them receive current; but I doubt whether anything like 10 per cent. take power. It is not easy to check, but I have been able to do so in an area—the Isle of Wight—which is served by only one supply company, where, of 1050 holdings of 1 acre and more, 75 take current, and of these only 31 take power.

The average size of holding in England is small—about 50 acres—and it would not be expected that a holding of less than 40 acres would take power. In the Isle of Wight, where there are 509 holdings of 40 acres and upwards, only 6 per cent. take power.

Whilst we hope for and expect a large and prosperous British agriculture, we must not overlook the fact that, besides the Free Trade economists who say it is not important, there are also some who would not be averse to it going back to its depressed conditions. Even if agriculture receives the benefits of all the various forms of support that are recommended in the report of the Committee on the Utilisation of Land in Rural Areas, it will still be necessary to employ every possible means to obtain the produce at the lowest possible cost. Wages are a dominant factor, and they will have to compare with those of the industrialist in the towns if the necessary man power is to be available, and so it will be essential to provide equipment to enable the workers to do much more than they have in the past.

I have referred to what mechanisation has already done, and will conclude by stressing the necessity of engineers continuing their efforts to make it possible for mechanisation to play an even greater part.

Scientists have provided farmers with a great deal of fresh knowledge in recent years, and the agricultural research stations and the Ministry of Agriculture have shown them how to make use of it.

I am sure that engineers, with their experience in co-operating with scientists in so many other fields, will not fail to play their part.

Civil Engineers and the Building Industry*

The third of the Discussion Meetings at the Institution of Civil Engineers, arising out of the Conference on "Civil Engineers and the Building Industry," was held on November 10th, when the subject for consideration was the contribution of science and research to the building industry. Sir John Thornycroft, President of the Institution, presided.

Sir Edward Appleton (Secretary of the Department of Scientific and Industrial Research) said that the greater part of the industrial research carried out in this country was done by a few big firms, chiefly firms whose very foundations had been laid on scientific discoveries, for example, of an electrical or chemical character. Research had made less apparent progress in the old-established industries, where the art of the craftsman had been highly developed, although even among these there was a growing tendency to replace the old rule-of-thumb methods by others embodying scientific practice. The outstanding feature of industrial research in this country was Government participation through the trade research association system. Autonomous research associations, supported jointly by the State and by industry, now numbered twenty-one, and their total expenditure was over half a million a year, of which one-third was contributed by the Government.

In the building industry the most prominent research department was the Building Research Station, but six other departments directly or indirectly served building and civil engineering, namely, the Forest Products Research Laboratory, the Fuel Research Station, the Geological Survey, the Water Pollution Research Laboratory, the Road Research Laboratory, and the National Physical Laboratory. In addition, there were at least ten of the research associations whose work touched productively on the material side of the building industry.

More research was wanted, particularly within the building industry itself. Such research must have two main divisions, the production of materials and the methods of using them in fabrication. It was also necessary to devise means whereby the results of research were suitably incorporated into the front-line activities of the builder himself. This second task was just as important as the first. Was it too much to hope that building and civil engineering interests would in the future find a means of providing for research on a scale adequate to their needs? The scope for interesting and useful work was almost unlimited. He instanced the problems of soil and water.

He also stressed the need for the closest possible contact between the research worker and the practical man in industry, the need for ensuring good standards in the execution of

* Articles dealing with others in this series of Conferences appeared in our issues of September 4th and 18th and October 16th last.

building and civil engineering work, and the need for the production of trained minds in this branch of knowledge. "It is far more important to see that men are turned out with an understanding of principles, a broad outlook, and a trained mind than to turn out men versed in the conduct of a particular operation."

Dr. R. E. Stradling mentioned how the old techniques of the craftsmen had been upset by modern demands, for example, speed. Modern conditions, such as the increased facilities for the transport of materials and men from one part of the country to another, had led to a clashing of different techniques, so that, for example, the craftsman of the North was trying to use the materials of the South for such an operation as plastering, or *vice versâ*. This had led to what he called "hopscotch technique" in some branches of the building industry. The craftsman under his new conditions might have a material not so easy to work with, and so he took his old material and added a little to his new. Thus by a simple change the whole of a carefully adjusted process might be upset.

Whether we liked it or not, we could not at the present moment have the traditional craftsmanship, and if things were allowed to drift as they were drifting, craftsmanship would be wiped out, which would be one of the greatest tragedies that could happen. There would not be much chance of preventing that unless, as Sir Edward Appleton had just suggested, they co-operated and tried to get the new spirit. In conclusion, he mentioned the need for what he called "user-logical research." The user of the building was the important person, and they ought to be able to give him the thing that he really wanted.

Professor J. D. Bernal said that formerly long time-lags between discovery and practice had been accepted as the natural thing, but in the war they had all learned how unnecessary these time-lags were, and how practicable it was to proceed from fundamental research to full-scale application in a time which was a mere fraction of what formerly was considered necessary—a time measured in months instead of in years or perhaps decades. It had also been found that that could only be done by some orderly and planned method and with close contact between the people in the field, the operational research workers, the people in production, the development and planning staff, and the academic scientists who were investigating fundamental principles.

He was quite sure that the method which had been elaborated for war purposes could be turned over straight away to the reconstructive purposes of peace. A great deal of the war effort had been concerned with building—the building of factories, fortifications, even of air raid shelters. These were all big building problems, all problems in which research had been used, and in fact problems in which, if there had been time to do the research, a little while before the war, better results would have been achieved.

Research in this war had for the first time, Professor Bernal went on, been carried out with something like adequate financial resources. The result was that it had been possible to put a lot of people on the job and to make their experiments in parallel instead of in series and so save an enormous amount of time. One of the things which had impressed him and made him change his mind in his experience of the war was that, while the scientist always tended to concentrate on such things as materials, when one got down to practical applications one found out that materials often turned out to be far less important than methods. The amount of change in a material might be relatively small; the amount of change in a new use of the material and the setting-up of the work might be far greater. Methods could be investigated just as scientifically as materials.

The prime necessity was to pull all this together, to keep the new knowledge of materials in close contact with the research on the development of methods. He thought there would be a great opportunity of doing that in Government-controlled building after the war. "It becomes an absolute necessity that the planning of these works should be on the basis of really effective research. We shall be sinking millions of money on things which will afterwards prove wasteful unless we economise by doing research first. Research is a form of economy. Many people ask where to stop in research. The answer is, stop when you are beginning to see the law of diminishing returns. That law will come in only when we have fully employed the intellectual power of the nation used in its most effective way. At present we can say that in the war we are just beginning to reach that stage of saturation."

Dr. W. H. Glanville said that he had seen research in the building industry grow from very small beginnings. He was one of the first six workers at the Building Research Station. What had been in his mind for some time was the need for operational research. The research worker must, above all things, keep himself in the closest possible touch with practice. One of the officers of the Road Research Laboratory who had recently been studying practice in America had told him of his deep impression of the amount of technical supervision and control exercised in that country. On one particular job more than 10 per cent. of the price of the contract was spent on technical control and on control in the laboratories. There should be greater use of specialists in particular operations in the industry. He did not believe that universities in the future would play so great a part in applied research; they would devote themselves to fundamental problems. Applied research was a matter for a team, each man occupied with his particular problem.

Mr. E. L. Bird spoke from the point of view of the architect. The job of the building industry was to provide the nation with the building it required—in other words, the customer came first. In the eighteenth century architects, builders, and others were concerned to a large extent with æsthetics; that had given place to the production of highly specialised buildings and to building for performance. But people would want grace and humanity once more. A house was a problem in thermo-insulation, in sound-proofing, in daylight illumination, the construction of the kitchen could be based on motion study, a perfect machine of house building might be made, but the owner might say that it was not cosy and that he preferred his old manor house, although it had no damp-courses, the sashes rattled, and there was death-watch beetle in the roof. A theatre was an affair of acoustics, of sighting lines, of emergency exits, but even when these problems had been solved, the public might say that it was ugly and had no atmosphere. In artificial illumination, the principles of the generation and distribution of electricity could be taught, also those of the reflection, intensities, and properties of light, and the requisite foot-candles brought on to the working plane, but beyond that was the question of handling light as a means of emotional appeal, providing glitter and stimulation or repose and intimacy. He believed that all these things might be taught, indeed they were already taught in many schools of art and architecture.

"It is intrinsically wrong that the architect designs and the engineer calculates, that the architect calls in the engineer when he wants his building to be certain to stand up (and most architects are woolly on the subject of structure), and the engineer requires the architect to add something pretty to his functional building, which is primarily designed for performance. That is wrong; they do not understand one another's aims. How are they to do so? Only by a basic technical education, embracing technics in its widest sense, and beginning somewhere down in the elementary schools, or at any rate at the age level of thirteen or fourteen years."

Principal F. E. Drury (L.C.C. School of Building) gave an account of the courses open to young people who were to enter the building industry. Education for the building industry could be considered in two groups. One of these included the junior technical schools, the forerunners, he hoped, of the technical high schools. The age range for the junior course was thirteen to sixteen; the ages for the senior full-time course ranged from sixteen to nineteen, and the university courses ranged from eighteen to twenty-one or higher. The second group comprised the instruction given in part-time classes, chiefly at evening schools. He desired to see the establishment of more junior technical schools. The local authorities had been invited by the Ministry of Works and Planning to co-operate, and he believed fifty such schools were already on the way. Senior full-time courses should be developed regionally, and as much as possible of the earlier work of the evening part-time courses should be transferred to part-time day.

Mr. Alister MacDonald said that committees were already being set up to discuss the contribution which science had to make to the building industry, but he wanted them to pass from the state of discussion to that of legislation. The new building legislation need not be complicated, and it should apply equally all over the country. There was already research available to prepare now a code of building on a solid basis. A general co-ordination of the results of research by some body like the Building Research Station would ensure that no materials were marketed or advice given upon them if they did not come within one of the appendices of the building code.

Mr. H. Kyffin Heyland, who is ninety-four years of age, made a vigorous contribution to the discussion on the training of youth for industry. He complained that a large majority of our ten million children were being educated up to joining the "black coat brigade," and not as manual workers, as he and many others were in the Victorian era, when this country rose to the zenith of its prosperity. Very little had been done to meet the lack of skilled labour in industries generally. The youth of this country should be better trained in craftsmanship.

Mr. Leonard Andrews spoke of the training of the parent of the young engineer. The parent still had a great deal to say in the training of his child. Many parents seemed to have had the experience that the money and time spent on training boys for engineering was a very bad investment from a monetary point of view, and the result was that they encouraged their sons to enter for other activities in which they would be better able to earn a living. He discussed ways in which the general body of citizens, including, of course, parents, might be made more scientifically minded, and called attention to the methods employed by the Royal Canadian Institute in fostering public interest in science and research.

Dr. E. W. Thomas, Head of the Building Department, Sunderland Technical College, said that there were three main things which concerned post-war planning: the designs, the materials, and the labour. The first two would be available, but it was very questionable whether labour would be there, for that would be determined by the question of technical education. In the provinces they were less fortunate than in London in the number of training colleges, and the building departments in those provincial schools were apt to become building, architectural, and civil engineering departments. If post-war labour was to be available, the support of building employers and trade organisations must be obtained for some form of apprenticeship, which would include compulsory education in technical classes; there were all sorts of compulsory things happening at the moment, and it would not do much harm if compulsion were applied to that particular branch of education.

The final speaker was Mr. R. C. S. Walters, who said that at the end of the war there would be a great number of engineers and people who had some knowledge of engineering—perhaps a broken training—who, having lived through some exciting experiences, would lack interest in humdrum jobs. One of the problems of the future would be to arouse interest among the half-trained. Employers could do much by facilitating attendance at technical colleges in the daytime and also by encouraging young men to attend engineering and scientific discussions.

THE PRODUCTION OF HAND TOOLS.—It is announced that the responsibility for planning production of all hand tools is to be taken over by the Director of Hand Tools of the Ministry of Supply.

The Engineer

NOVEMBER 13, 1942

VOL. CLXXIV No. 4531

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NOTICES TO READERS

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

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CHANGES OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both old and new address,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

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THE YOUNG DELINQUENT

THE latest Report from the Select Committee on National Expenditure contains a short but disturbing history. In a certain shipyard—unnamed—there were four youths of seventeen years of age who were persistent absentees. Nothing would bring them to a proper sense of their duty. They were reported by the Yard Committee; they were interviewed by the National Service Officer, and "directions" were issued under the Essential Work Order. The four youths snapped their fingers at all these efforts to make them behave themselves. They continued to defy authority. After some six fruitless months the National Service Officer told the employers that "the cases would be referred for consideration of prosecution," but nothing was done. The National Service Officer took no action because it is the "deliberate policy of the Ministry not to prosecute juveniles except in flagrant cases and after all alternative measures have failed."

If this case stood alone it would be bad enough; but it does not stand alone. Other cases have been made public or brought to our personal attention. The offence is serious, not only because persistent and inexcusable absenteeism delays the output of war material, but because it has a pernicious effect upon the *morale* of fellow-workmen. It seems that the Ministry of Labour has not the power or the determination to put an end to an intolerable state of affairs. Fines and even imprisonment for disobeying an Essential Work Order have been found ineffective. The fines were paid by sympathisers and not by the offenders themselves, and if the sentence was imprisonment there was an outcry of martyrdom. In this quandary the National Service Officers, whose duty it is to see that discipline is maintained, refrained from taking action. The obvious course would be to de-reserve the offenders and enlist them in one of the Services. But to that there is the drawback that industry needs labour and that employers are unwilling to part with younger men on whom they must depend when peace returns, and finally, as the Report points out, it "has no application to those under the age of military service." Nevertheless, the Committee recommends that reservation should be withdrawn "if workers are not doing satisfactorily the work for which they have been reserved."

We do not wish to exaggerate an evil which, after all, if we are to accept the recent Report by the Ministry of Labour on Absenteeism—see THE ENGINEER, October 30th—is not extensive, but we do think it should be made clear that it is in the power of delinquents to defy not only those set in authority over them, but the appeals of their fellow-workers represented on the Works or Yard Committees. That is, to our minds, a very serious state of affairs, pregnant with dangerous possibilities for the future. Even the most advanced views on the future position of labour cannot reject the fact that discipline is imperative. In recent years labour has shown a marked tendency to defy its own appointed leaders drawn from its own ranks. If it can with impunity defy also employers and even authorities appointed by Government, it is clear that the whole basis of collective agreements must be brought to nought. The result would be disastrous, not to industry alone, but to labour itself, and to the whole community. That is why we have thought it desirable to give some attention to cases which may be few in number and small in themselves. If they are symptomatic of the attitude of young labour, the labour of the future, a great effort both by the unions and by Government must be made to check the malady in its early stages.

Superheating at Sea

ON September 24th Mr. E. H. Watts, a well-known shipowner, published in *The Times* a letter challenging the Admiralty's decision with regard to superheaters in standard ships. Speaking from experience with some of the ships of his own company, he stated that saturated ships were burning 2000 tons of coal more per year than superheater ships. Assuming that the indicated horsepower of the engines concerned is in the neighbourhood of 2300, a simple calculation will show that this figure is on the high side, unless comparison is made with an uneconomical saturated ship. In round figures it may be taken that a triple-expansion steam ship will consume between 1·6 lb. and 1·8 lb. of coal per I.H.P., and a superheated steam ship of the same class 1·35 lb. But allowing for this pardonable exaggeration, the fact is incontestable that a considerable saving of coal results from the use of superheated steam, and it may therefore be worth while to examine for a moment the reasons why superheating was not included in the specification.

Although American and Canadian-built standard ships were being fitted with superheaters, the shortage of steel in this country was so acute that the early Admiralty specification called for saturated ships, but it should be noted that provision was made for the ready conversion to superheat when circumstances permitted. We need not remind our readers that for temperatures in the neighbourhood of 600 deg. Fah. steel pipes are necessary, and there was such a dearth of them that a bottleneck would have existed and delayed the output of much-needed tonnage. Moreover, the superheater calls for additional man power in the shops and more experienced men at sea. High temperatures introduce their own operational problems, and at that time it was desirable that the calls upon the engine-room staff should not be too severe. Examples are not wanting of bad damage to superheaters early in a ship's life owing to inexpert handling. It was much easier to find men capable of handling saturated ships than superheated ships. For these reasons the policy adopted by the Admiralty was practically forced upon it at that time. It had to choose between the economy of superheater ships on the one hand and the delays in getting them to sea and personnel difficulties ashore and afloat on the other.

But in recent months there has been an improvement in the supply of steel, and, at the same time, an urgent demand for the saving of coal. Thus the possibility of fitting superheaters to standard ships improved just when it became of increasing importance that they should be fitted. Hence it is the practice now to fit superheaters in new standard ships, and it may be assumed that existing saturated ships will be converted whenever the opportunity arises.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

HIGH-SPEED STEEL

SIR,—The correspondent opening this discussion invited an explanation of variable results he was getting from high-speed lathe tools hardened by himself. My reply pointed to the necessity to any hardener of a testing machine to verify the accuracy of the heat treatment. A concern of the standing of Alfred Herbert, Ltd., could well be expected to possess the necessary equipment, and the personnel to

use it, and so to be clear of this issue. Nevertheless, there are implications in Sir Alfred's letter which embolden me to become more expansive.

We can rely on our steel makers to give us the right composition, and we can equally rely on reputable tool makers to supply the steel in its correct degree of hardness. But is high-speed steel of such a nature that it can be correctly hardened by engineering concerns without specialised furnace equipment and without means to verify the accuracy of the treatment? This question can be answered emphatically in the negative for the following reasons:—The type of furnace available for such work has an indeterminate performance and the correct temperature for quenching is assumed to be reached when incipient fusion or "sweating" is observed. With this somewhat primitive procedure it is too much to hope that tools of various sizes and shapes will be heated uniformly within the necessary narrow limits. We are left too much to the judgment of the workmen. A curious feature of these high-tungsten steels is that full hardness is not realised by quenching (or by air blast cooling) from the hardening temperature. The subsequent tempering operation at lower temperature (also called secondary hardening) increases the hardness by transformation of the residual austenite to martensite. Not only is accurate temperature control necessary for this process, but the duration of it is a factor of prime importance. The optimum heat-treatment conditions can be determined only with knowledge of the composition of the steel which is not to be expected from a user who usually employs a number of brands. Further, the attainment of freedom from undue brittleness is as important as the realisation of the necessary degree of hardness, and such has to be kept in view in determining the heat treatment.

With the coming of the "66" war substitute steel, another difficulty arises. This steel does not "sweat" like the high-tungsten steels, and a temperature indicator and a proper equipment of salt-bath furnaces become essential to the works doing their own hardening.

The ultimate proof of the quality of a cutting tool should be its performance under working conditions, but in actual practice reliance cannot be placed on workshop reports as a safeguard. Our tool manufacturers have maintained such a high-grade product that high-speed steel has come to be regarded as an unvarying standard by which the machining properties of materials can be measured. During thirty years' close contact with metallurgical and machining activities, I have encountered numberless cases of complaints of undue hardness of various materials, but never once have I heard from the workshop of the quality of the cutting tool being in question. This state of affairs must have done much to mislead concerns doing their own hardening. Let me give one typical case. Complaints were received from a works in the Midlands of an alloy steel being found to be too hard to machine with commercial success. Investigation proved the material to be satisfactory and the cutting tools were then examined. Out of 400 lathe tools, less than one-half had a Rockwell C hardness of more than 50; only thirty-two were over 60 Rockwell, and only two were fully hardened to 64. In another recent case complaints of undue hardness of an alloy cast iron revealed that the taps being used had a Rockwell C of 47.

I quite agree with Sir Alfred that 60 Rockwell "gives quite good results"; in point of fact, I have advocated this value for the rejection limit in a number of instances, not as the ultimate objective, but as an introduction to improvement. Such, however, does not alter the fact that a hardness of 64 can regularly be realised with lathe tools if the proper methods are adopted and with appreciable benefit. The imperfect hardening of high-speed steel has been responsible for much unnecessary use of tungsten carbide.

If by "reclaimed material" Sir Alfred refers to the forging of tips from old solid tools, I should say that such work can be carried out without sacrifice of hardness. The use of a hardness tester cannot in itself fully prove satisfactory heat treatment—there are other factors—but it constitutes an indispensable guide to the concern doing its own hardening.

Finally, we may look at the subject from a wider angle. High-speed steel is the very foundation of modern machining methods. It stands alone in its importance to production. In our quest for increased output, the first rational step should surely be to verify that there is no shortcoming in this most important of the many factors involved. Surprise—and profit—await those concerns doing their own hardening who will critically investigate the results.

S. F. Barclay.

Sale, October 29th.

THE CONSTRUCTION OF PRESSURE GAUGES

Sir,—Can any of your readers tell me the reason for the widespread and, in my opinion, foolish practice of fitting a pointer stop right on the zero line of the dials of pressure gauges?

This makes it impossible to detect even a large error of the zero reading if the error is in the negative direction. Surely the provision of a mechanical stop is not the only way of ensuring a correct zero reading. Electrical instruments, even down to the cheapest—with the exception of toys—have a pointer stop a little below zero and they are provided with an adjusting device by which a zero reading may be corrected from time to time.

It is appreciated, of course, that means must be provided to prevent the pointer commencing to make a second revolution round the scale under conditions of greatly excess pressure, but it is considered that there are positions for a stop better than on the zero line.

S. A. Strode, A.M.I.E.E.

Ashford, Middlesex,
November 4th.

A CHANNEL SUSPENSION BRIDGE

Sir,—In common, probably, with many readers who rarely listen to B.B.C. programmes, I have to thank you for printing in full the speech recently broadcast by Professor Inglis.

In the course of the speech reference was made to a number of long-span suspension bridges which may justly be regarded as triumphs of engineering, but had Dr. Inglis overlooked the recent failure of the Tacoma Narrows bridge? The evidence showed that the failure was due to the low span-to-width ratio, a fact which has a bearing on a suspension bridge spanning the English Channel, according to the Professor's flight of fancy. It is to be regretted that Dr. Inglis did not state the width of the proposed bridge, and add that even if the supporting towers were only 20 miles apart they would be a mile and a quarter high if the "dip" of the cables was one-sixteenth the span, as is customary.

E. B. Parker.

Wirral, Cheshire,
November 8th.

Sixty Years Ago

The Foundering of the "Austral"

On November 11th, 1882, the Orient liner "Austral" sank in Sydney harbour under conditions closely similar to those which attended the foundering of the "Royal George" at Portsmouth in 1782 and of the "Mary Rose" at Spithead in Henry the Eighth's reign. The "Austral" was a new ship of about 5500 tons, a length of 456ft., a breadth of 48ft., and a depth of hold of 34ft. She had given her builders and owners every reason to believe that she was well constructed and up to the time of her foundering her performance had been satisfactory. In April, 1882, she made the passage from the Clyde to the Thames in the light condition with nothing but 800 tons of water ballast in the tanks in her bottom. Soon afterwards she sailed on her maiden voyage to Australia. On the date we have named she was lying in Sydney harbour taking in coal in apparently perfect security. Suddenly, when she had taken on 1500 tons of coal, she heeled over, water entered her coaling ports, and she sank. The mishap aroused considerable anxiety in the public mind. It seemed to suggest that, in spite of recent developments in the science of naval architecture, there was still some potentially disastrous factor in the construction of ships which designers and builders had not yet mastered. In our issue of November 17th, 1882, we sought to explain the cause of the mishaps in the light of the information about it which so far had reached us. We found it in the fact that many good steamers, although they possessed a great righting moment when heeled over to a considerable angle, had not enough initial stability when light and without ballast to enable them to stand upright. In other words, their metacentric height in the vertical condition was zero or even negative and did not become effectively positive until some angle of heel had been reached. It would appear that through carelessness on the part of someone the "Austral," before being coaled, had been deprived of her water ballast or a large part of it. In that condition she had no initial stability, and as the coal was loaded into her bunkers she started to heel. Partly because the coal was not properly trimmed and partly because there was, presumably, some loose water in her tanks, she heeled over until her coaling ports were submerged. The "Royal George," we may recall, foundered while careened for the purpose of stopping a leak and by heeling over to an extent sufficient to admit water through her gun ports. The "Mary Rose," with five or six hundred men on board, was lost, in Rayleigh's words, in consequence of "a little sway in casting the ship about, her ports being within 16in. of the water."

Wages in the Engineering Industry

On Thursday, November 5th, representatives of the engineering trade unions met the representatives of the Engineering and Allied Employers' National Federation in London and put forward their claims for increased wages. For the first time for many years all the forty unions are making a united claim for an all-round increase of 11s. a week, an increase equivalent to 33⅓ per cent. of base rates to all plain time workers, and a full restoration of the overtime, night shift, and Sunday working conditions to what they were before June, 1931. The claim is made on behalf of about 1,500,000 male engineering workers, and a separate claim is being made for the women workers in the industry. The total cost of the increase would appear to be between £65,000,000 and £100,000,000 a year. In the unavoidable absence of Mr. J. Tanner, the President of the Amalgamated Engineering Union, who is at present in America, the case for the unions was put by Mr. J. Kaylor, the senior member of the A.E.U. Executive Committee. In the main, the claim is based on the increase in the cost of living, the value of the work done, and the place of engineering workers in the industrial life of the country. It was argued that a large increase in wages was justifiable, and that the engineering industry was in a position to make such an increase. In his reply, Sir Alexander Ramsay, speaking for the Employers' Federation, said that the claim and the arguments advanced by the unions would be very carefully considered by the employers. Their reply, Sir Alexander said, would be given on a day to be arranged, bearing in mind that the unions had asked that there should be no avoidable delay in preparing the answer.

Recent Developments in Refrigeration*

By LORD DUDLEY GORDON, D.S.O., M.I. Mech. E. (Member of Council)†

No. I

General

REFRIGERATION is concerned with temperatures below the normal atmospheric temperature. The lowest limit is obviously absolute zero, −273·144 deg. Cent., to which the nearest approach has been made at the Kamerlingh Onnes Laboratory at Leiden, where an absolute temperature of 0·005 deg. K. has been reached.

More regular practice begins at the liquefying temperatures of certain gases at atmospheric pressure. For instance, the temperature of liquid oxygen at atmospheric pressure is −183 deg. Cent., nitrogen −195·8 deg. Cent., and liquid air about −192 deg. Cent. The liquefaction of air by Linde in 1894 soon led to the development of liquefied gases used for welding and cutting, and to the process for the synthetic production of ammonia; but in these processes refrigerating machinery is only used for precooling the original mixture of gases to a temperature of about −60 deg. Fah., the remainder of the process being carried out by means of compression to a moderate pressure, by rectification and heat exchange between the gases handled.

For temperatures down to −60 deg. Fah. normal ammonia refrigerating machinery can be used economically, but there is an increasing demand in chemical and other processes for refrigerating temperatures down to −100 deg. Fah. or even lower, and for such temperatures refrigerants other than those in use for the usual processes to which refrigeration is applied become necessary. Table I shows the triple point and the normal boiling point of various refrigerants which may be used for these very low temperatures. Some of these are not readily obtainable. It will be seen that both ethane and ethylene are particularly suitable, and have been successfully used in large-scale applications of low temperatures. Such low temperatures are reached by means of the "cascade" system, to which reference will be made later, ethylene with its low critical point, or some other low-temperature refrigerant being used only in the last stage, the higher stages usually employing ammonia or carbon dioxide, or sometimes both.

TABLE I.—*Low-temperature Refrigerants*

Refrigerant.	Ethane, C_2H_6.	Ethylene, C_2H_4.	Propane, C_3H_8.
Critical point, deg. Fah.	89·8	49·1	204·1
Triple point, deg. Fah.	−298·5	−272·92	−309·8
Boiling point at atmospheric pressure, deg. Fah.	−127·5	−155·02	−48
Vapour pressure at 5 deg. Fah., lb. per square inch abs.	236·5	416·4	42·1
Vapour pressure at 86 deg. Fah., lb. per square inch abs. ...	682·7	—	155·3
Volume, cubic feet per lb. at 5 deg. Fah. ...	0·629	0·273	2·48
Volume, cubic feet per lb. at 86 deg. Fah. ...	0·122	—	0·717

During the period when mechanical refrigeration was being developed to its present stage, the main uses, such as ice making, cold storage both on board ship and on shore, as well as applications in breweries, demanded temperatures from 0 deg. Fah. up to about 40 deg. Fah., and at these temperatures the most suitable refrigerants were found to be ammonia, carbon dioxide, and sulphur dioxide. Table II shows the triple point and the normal boiling point of these refrigerants. The objections to sulphur dioxide are that it is highly toxic and that the least trace of moisture makes it highly corrosive. The latter frequently led to trouble with the gland of the horizontal double-acting compressor, which in the early days was the almost universal form of refrigerating machine. The compressor rod, being exposed to the low temperature inside the compressor on the suction stroke, was apt to become cool. When passing into the atmosphere moisture was deposited on it, through the formation of sulphuric acid, which quickly caused corrosion of the gland packing. For this and other reasons, sulphur dioxide gradually fell into disfavour, so that the overwhelming majority of refrigerating plants working on land came to use ammonia as the refrigerant. Ammonia is in abundant supply and its heat of vaporisation is very high. The only objection to the use of ammonia is that it is toxic, and a serious escape causes danger to life. This is one of the reasons why it is not favoured on board ship and in positions where the machinery must be in a confined place, from which there is not easy access to the outside air.

TABLE II.—*Refrigerants for Use in Large Cold Stores*

Refrigerant.	Ammonia, NH_3.	Carbon dioxide, CO_2.	Sulphur dioxide, SO_2.
Critical point, deg. Fah.	271·4	87·8	315·1
Triple point, deg. Fah.	−107·86	−69·9	−98·9
Boiling point at atmospheric pressure, deg. Fah.	−28·0	−109·3 (solid)	13·99
Vapour pressure at 5 deg. Fah., lb. per square inch abs. ...	34·27	331·9	11·71
Vapour pressure at 86 deg. Fah., lb. per square inch abs.	169·2	1042·0	66·85
Volume, cubic feet per lb. at 5 deg. Fah.	8·150	0·2660	6·500
Volume, cubic feet per lb. at 86 deg. Fah.	1·772	0·04789	1·265

On board ship and in confined spaces carbon dioxide is the most suitable refrigerant for larger-size installations in the range of temperatures under consideration. The volume per pound is low so that the size of compressor is less than for other refrigerants, and it has no corrosive effect on non-ferrous metals as ammonia has in the presence of moisture, so that it is convenient in marine installations to use copper coils for the condenser through which sea water is circulated. Moreover, carbon dioxide is non-toxic and quite harmless, except in high concentrations, when it will cause suffocation, but being heavier than air, a large amount can be allowed to escape without causing inconvenience to a person standing upright in the engine-room.

During the period between the last war and the present war, developments took place which had a great effect on the design of refrigerating equipment. It has already been said that the main uses for refrigeration which led to the development of the industry were the production, transport, and storage of perishable foodstuffs. The last-named link in this chain was provided by the advent of the domestic mechanical refrigerator, which, in the period immediately preceding this war, had reached a high stage of development. This had two results so far as the refrigerating equipment industry was concerned. Ice factories, which in many countries, particularly in the United States of America, had been the most important purchasers of refrigerating machinery, found themselves working at reduced outputs, and at the same time vast numbers of refrigerating machines of very much smaller size than had ever previously been constructed were required to meet the new demand. Machines of these small sizes could not be manufactured conveniently and cheaply if they had to make use of refrigerants with such high vapour pressures as carbon dioxide and even ammonia; so many early types of domestic refrigerator made use of sulphur dioxide, which, because of its low vapour pressure, rendered it possible to construct both the compressor, the piping forming the condenser, and the evaporator on scantlings light enough to be brought within the small space available. This development was not confined to the domestic refrigerator, but was also applied to retail food shops, which had previously been amongst the most important purchasers of ice. Not only did all these machines have to be made in comparatively small sizes, but they had to be rendered completely automatic in operation, requiring no attention whatever from the user, who did not even have to depress a switch like the domestic user of a vacuum cleaner or a wireless receiving set.

Now the disadvantage possessed by sulphur dioxide of being highly toxic, as already mentioned, led to the search for some new refrigerant which would have a low vapour pressure and at the same time be non-toxic. Table III shows the properties of some of the gases which are used as refrigerants for this class of refrigerating machinery. It must be borne in mind that in this range of refrigeration specially low temperatures are not normally required. Of these refrigerants, methyl chloride was found to be readily available and possessed desirable properties.

TABLE III.—*Refrigerants for Domestic and Air Conditioning Purposes*

Refrigerant.	Methyl chloride, CH_3Cl.	Dichlorodifluoromethane ("Freon" or "F.12"), CCl_2F_2.
Critical point, deg. Fah.	289·6	232·7
Triple point, deg. Fah.	−144	−247
Boiling point at atmospheric pressure, deg. Fah.	−10·76	−21·7
Vapour pressure at 5 deg. Fah., lb. per square inch abs.	21·15	26·51
Vapour pressure at 86 deg. Fah., lb. per square inch abs.	94·70	107·9
Volume, cubic feet per lb. at 5 deg. Fah.	4·471	1·485
Volume, cubic feet per lb. at 86 deg. Fah.	1·081	0·389

Refrigerant.	Methylene ("Carrene 1"), CH_2Cl_2.	Trichloromonofluoromethane ("Carrene 2" or "F. 11"), $CFCl_3$.
Critical point, deg. Fah.	421·0	388·4
Triple point, deg. Fah.	−142·0	−168
Boiling point at atmospheric pressure, deg. Fah.	103·7	74·66
Vapour pressure at 5 deg. Fah., lb. per square inch. abs.	1·17	2·93
Vapour pressure at 86 deg. Fah., lb. per square inch abs.	10·60	18·28
Volume, cubic feet per lb. at 5 deg. Fah.	50·0	12·195
Volume, cubic feet per lb. at 86 deg. Fah.	6·667	2·242

* The Institution of Mechanical Engineers, November 6th. Twenty-ninth Thomas Hawksley Lecture.—Abstract.

† Chairman, J. & E. Hall, Ltd., Dartford.

It is, however, inflammable under certain conditions, and, though not highly toxic, will cause illness if inhaled in fairly large quantities. On the other hand, dichlorodifluoromethane, which for greater convenience is usually referred to as "Freon," is non-toxic and therefore admirably suited for use where there may be numbers of people present with no skilled, nor indeed any, operator available. Freon is very suitable for use, not only with the range of temperatures required for the cold storage of food, but also

FIG. 1—*Westinghouse Compressor (Electric Drive)*

with the higher temperatures made use of in air conditioning. The only objections to its use are its very high cost and the fact that the only present source of supply is in the United States of America. As it is quite odourless and the vapour pressure is low, the detection of leaks, which is most important when using a high-priced refrigerant, becomes a matter of great difficulty. Very special precautions must therefore be taken at every conceivable source of leakage, such as joints and glands.

The evolution of the domestic refrigerator

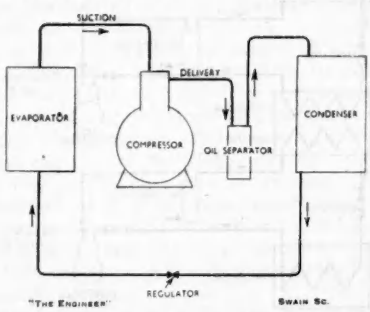


FIG. 2—*Circuit for Wet Compression, with Hand-operated Regulator*

took place simultaneously with the great development, commonly known as air conditioning, which was concerned with controlling the temperature and relative humidity of the air used for ventilating large buildings, such as cinemas and theatres, office blocks, and hotels. These two developments have changed the outlook of the refrigerating engineer to such an extent that, certainly in the United States, they constitute between them by far the greatest proportion of the demand for refrigeratng plant, the former chief demands for cold storage and ice-making having fallen to quite a low place.

Refrigerating Compressors

The original refrigerating machines were in nearly every case horizontal slow-running, double-acting compressors, the piston being designed with spherical ends and the valves so arranged in the end covers that the clearance was reduced to a minimum.

The horizontal type of compressor, par-

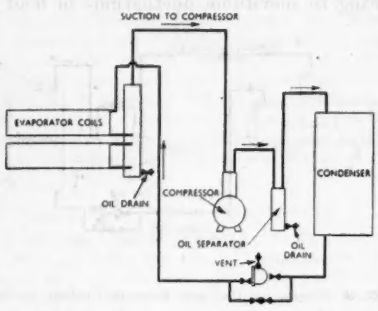


FIG. 3—*Circuit for Dry Compression, with High-pressure Float Regulator*

ticularly in the ordinary commercial large-size refrigerating plant making use of ammonia, continued in favour in Germany and most other countries in the Continent of Europe up to quite recent years. During the past twenty years the high-speed vertical compressor has to an increasing extent replaced the horizontal compressor in this country and in the United States of America. The adoption of the vertical type has been accompanied by the usual increase in speed which is a result of the development of modern materials and modern workshop practice. This change has had the usual effect of saving a large amount of space, and the area now required to be set aside for a large refrigerating installation is only a fraction of what it was thirty or more years ago. The most usual form has a vertical

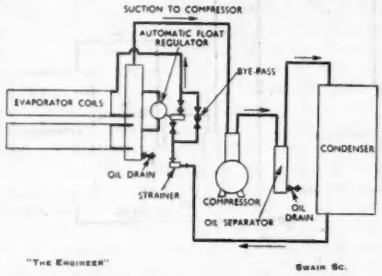


FIG. 4—*Same Circuit as in Fig. 5, but with Low-pressure Float Regulator*

single-acting cylinder with the suction valves arranged in the head of the piston and the delivery valves in the cylinder head, which in most cases is designed to form a safety head. If by any mischance a large volume of liquid ammonia is drawn in with the suction stroke, it cannot be cleared through the delivery valve, and a disaster may occur through the cylinder head being blown off and the ammonia escaping into the engine-room. The single-acting design makes it possible to house the delivery valves in a cylinder head held in position by powerful springs, which will only allow the whole head to rise if liquid is present in such quantities that it will not pass through the delivery valves. A further advantage of the single-acting vertical machine is that the crank case can be made completely enclosed, and is subjected to a pressure only 2 lb. to 3 lb. per square inch above the ammonia suction pressure. The only gland then becomes that round the rotating crankshaft. It is obviously much simpler to make a gland of this type gas-tight than one through which a piston-rod is reciprocated.

A variant of this form of compressor is one in which sleeve valves are used in the same way as in some other gas compressors and internal combustion engines. In the most usual arrangement ring plate delivery valves are placed in a safety head, as already described. The suction gases are controlled by the ported sleeve which surrounds the piston and acts as a liner inside the cylinder. A reciprocating motion is imparted to the sleeve by excentrics on the crankshaft. With this design it is easy to provide a second set of ports in the sleeve to admit gas at a higher suction pressure later in the stroke, on the supercharging principle, thus allowing

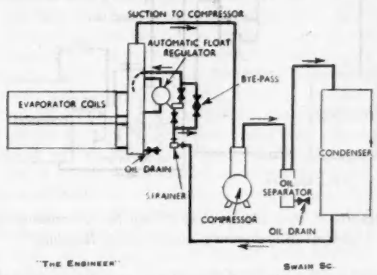


FIG. 5—*Circuit for Dry Compression; Direct Feed into Separator*

one cylinder to handle simultaneously gas at two different suction pressures. These compressors follow normal compressor design and are fitted with forced lubrication.

The smaller sizes used for domestic applications and for the smaller commercial work follow the same general lines modified only to suit their difference in size and the refrigerant used. The smaller sizes are usually lubricated by means of splash lubrication instead of by forced feed.

Fig. 1 illustrates a type of compressor now widely used in the U.S.A. The influence of motor-car and aero-engine design is noticeable. With this V arrangement of the compressor cylinders and enclosed crank case, a large output is obtained from compressors

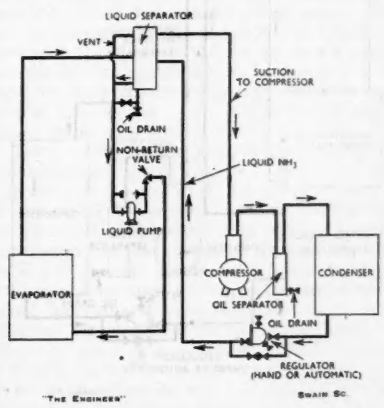


FIG. 6—*Circuit Comprising Pump for Circulation of Evaporating Liquid; High-pressure Float Regulator*

occupying a small amount of space. The electric motor driving the compressor is contained within the same frame as the crank case, so that there is no gland through which the refrigerant might escape.

Turbo-compressors, usually in a multi-stage arrangement, have been used in recent years. Most of these are of the larger sizes and their development has depended not only upon progress in design, but also on the use

of refrigerants with a high boiling point and a high molecular weight. Ammonia, ethyl chloride, and "Freon 11" have been used in turbo-compressors, the latter refrigerant working in most cases below atmospheric pressure. This avoids the risk of outward leakage of the refrigerant, but special precautions must be taken to prevent air from being drawn into the system. In some cases a special vacuum pump has even been employed to overcome this risk. I have already said that the turbo-compressor has

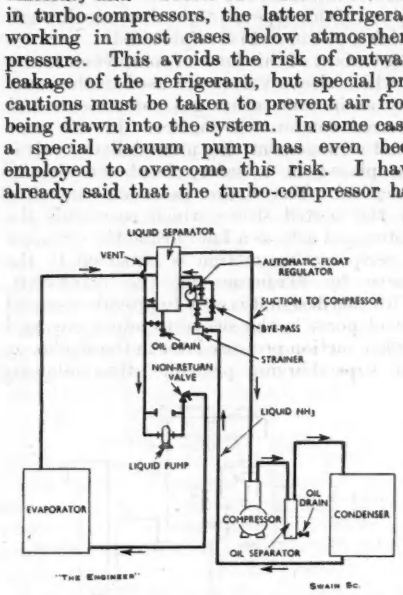


FIG. 7—*Circuit Comprising Pump for Circulation of Evaporating Liquid; Low-pressure Regulator*

been used as a refrigerating machine mainly in the larger sizes; but for more moderate capacities a rotary compressor is often employed, types of which were in process of development in more than one country immediately before the commencement of this war.

Another change which follows the development of other types of compressor is the increasing adoption of the V belt drive, which

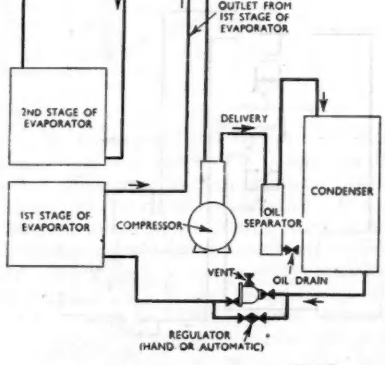


FIG. 8—*Circuit for Two-stage Evaporation (Ammonia)*

in recent years has tended to displace the arrangement by which compressors were coupled directly to the electric motor or other prime mover, though the latter arrangement is still favoured for the very largest sizes.

Refrigerating Circuits

In the original evaporator the refrigerant was almost invariably distributed over a number of coils, with low velocities of both the refrigerant and the liquid to be cooled. In refrigerating evaporators of the modern type means are employed to increase the rate of circulation, and it is interesting that in steam boilers of the La Mont type the arrangement for circulation by means of a pump is very similar to that widely adopted for refrigerating evaporators.

Fig. 2 shows the vapour compression refrigerating circuit in diagrammatic form, to illustrate the sequence of events for wet compression, with a hand-operated regulator. The adjustment of the regulator controls the flow of liquid refrigerant from the condenser. Owing to inevitable fluctuations in load it

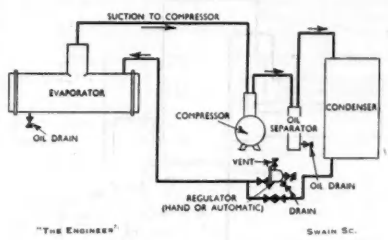


FIG. 9—*Circuit for Use with Brine as Cooling Medium*

is impossible to obtain, with a hand-operated regulator, a permanent setting which will alllow the liquid refrigerant to pass to the expansion side always at exactly the same rate at which it is formed in the condenser. In practice, the first part of the condenser is used for cooling the gas delivered from the compressor through the superheat range. The major portion is utilised in removing the heat of condensation, so changing the vapour to a liquid, and the remaining part of the condenser cools the liquid to within a few

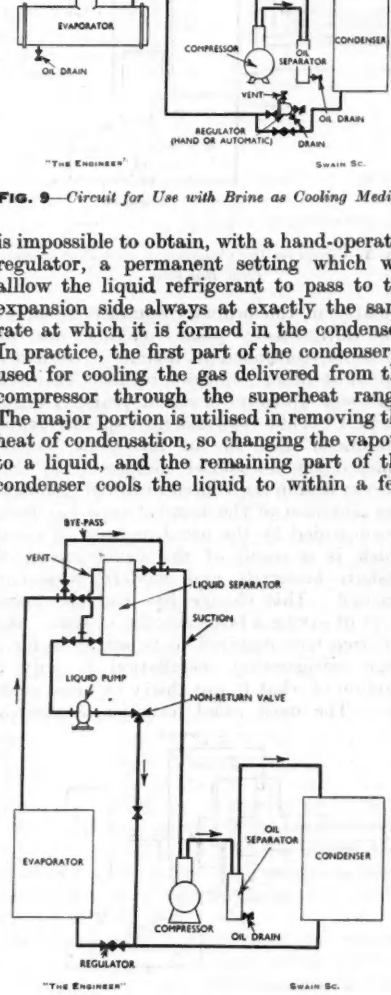


FIG. 10—*Multiple Circuits; Path of Liquid Refrigerant*

degrees of the water temperature. To ensure that the regulator shall be constantly fed with liquid, the usual arrangement is to provide, at the outlet from the condenser, a liquid receiver from which the liquid is fed to the regulator. In the evaporator the refrigerant returns to the vapour state, absorbing from the surrounding medium the heat required for the change. The vapour formed, as drawn into the compressor, is fully saturated and nearly always contains some entrained liquid.

Fig. 3 shows the circuit of Fig. 2 modified to operate on the dry-compression system. The diagram indicates an automatic regulator of the float type, which is usually associated with dry compression, but is not an essential feature. With the arrangement shown, this automatic regulator takes the form of a float which opens an expansion valve as soon as liquid is present. This has the effect of keeping the condenser completely drained of liquid, and no part of the condenser is used for supercooling the liquid after condensation. The evaporator circuit is provided with a liquid separator consisting of a vessel of such a cross-sectional area that the velocity of the gas flow becomes sufficiently low to allow any free liquid to fall back into the separating vessel and so to return to the evaporator circuit. The gas drawn back to the compressor is thus completely free of entrained liquid, and becomes in almost every case slightly superheated in its passage from the separator vessel to the compressor.

Fig. 4 shows the same circuit arranged with a different type of float regulator, which does not necessarily drain the whole of the liquid from the condenser but maintains a

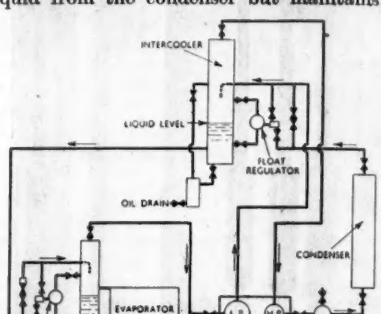


FIG. 11—*Circuit Diagram for Two-stage Arrangement*

constant level in the evaporator coils. This arrangement is particularly suitable where more than one cooler or other form of evaporator is placed at different levels in the same building.

A variation of this circuit is shown in Fig. 5. With this arrangement the liquid passing from the expansion valve is fed directly into the separator vessel instead of to the evaporator coils, which, except for the

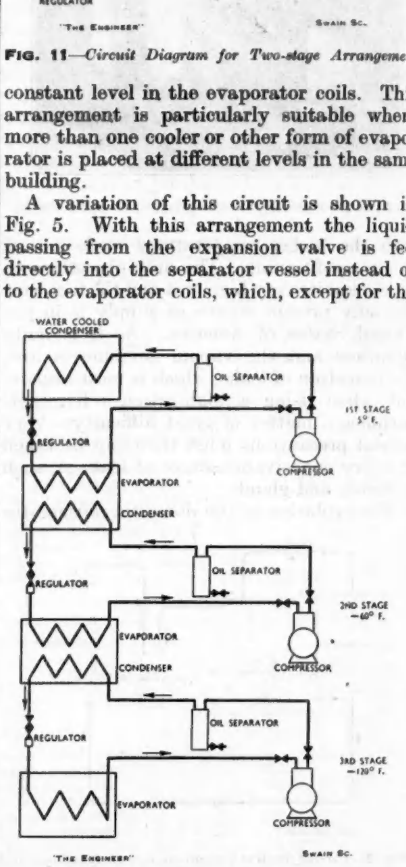


FIG. 12—*Circuit Diagram for "Cascade" Arrangement*

top two or three, are kept completely flooded.

The circuits I have described are used where the evaporator coils form a direct expansion circuit, usually in the form of an air cooler; but where the evaporator coils take the form of grid piping dispersed possibly throughout a number of chambers in a cold store, it is usually necessary to circulate the evaporating liquid through

these coils by means of a pump. Figs. 6 and 7 show the circuits adopted in such cases. These may comprise either a high-pressure float regulator draining the whole of the liquid from the condenser or a low-pressure type maintaining a constant level in the liquid separator vessel.

In some of the earliest examples of this system of recirculation of the ammonia liquid, a separator vessel was provided high in the building—sometimes on the roof in an insulated chamber—so that the liquid could be fed by gravity to various expansion circuits, as indicated in Fig. 8. The diagram illustrated shows the evaporation carried out in two stages, which is a great convenience in the case of a cold store requiring differing temperatures in rooms set aside for different classes of produce.

When brine is used as the cooling medium, a somewhat simpler circuit can be used, a very common form being that illustrated in Fig. 9, where the evaporator takes the form of a horizontal vessel containing the liquid ammonia, the brine being passed through tubes held in end plates, so that the ammonia boils by absorbing heat from this brine. In many cases the vessel is fitted with a dome to ensure the separation of any free liquid from the gas passing to the compressor. The form of this evaporator is, indeed, similar to a locomotive type steam boiler.

In some cases it is found convenient to pass the liquid refrigerant, collected in the separator on the suction side, to the high-pressure side of the regulator, so that it joins the liquid passing direct from the condenser. This arrangement has been applied with most useful results in cases where the dry compression cycle is to be applied to an existing plant having several circuits spread over a number of freezing chambers or cold stores. The diagram shown in Fig. 10 is typical of this arrangement. A difficulty has to be faced in applying this form of liquid recirculation to an old refrigerating plant, in that the individual circuits on the evaporator side are very frequently much longer than is desirable for recirculation of the liquid, the usual practice in new plants being to use very short individual coil lengths.

When the temperature of evaporation has to be so low that to reach the condensing pressure, the ratio of compression becomes greater than is desirable in a single stage, two or more stages of compression must be used. A usual form of circuit using a two-stage reciprocating compressor is shown in Fig. 11. The gas leaving the high-pressure cylinder passes to the condenser, where it becomes liquid and is drained by means of a float valve into the liquid line. This liquid is injected into the delivery from the low-pressure cylinder and passes with it to the intercooler vessel, where the evaporation of a small portion of the liquid cools the gas on its way to the high-pressure suction. The main bulk of the liquid falls to the bottom of the intercooler, from which it is drained by a second float valve into the evaporator, where it boils and is drawn as a vapour into the low-pressure suction.

An intercooler of this type is essential where temperatures are so low that there would be risk of freezing in an intercooler using water as the cooling agent. When the intercooler is always above freezing point, a water-cooled heat exchanger is frequently used.

When the temperature required is so low that it is desirable to use more than one refrigerant, the "cascade" principle may be employed. Fig. 12 is a diagram of such a circuit, using three refrigerants. The highest stage is a normal ammonia circuit with a condenser cooled by water. The evaporator of this circuit is used for cooling the carbon dioxide condenser of the second stage, and the carbon dioxide evaporator in its turn cools the condenser of the lowest state circuit using ethylene. The evaporator of this last circuit provides the low-temperature cooling required. Each refrigerating circuit is entirely independent, and makes use of the refrigerant most suited to the range of temperature through which it will have to work.

(To be continued)

Merchant Shipbuilding and Repairs

THE Seventeenth Report from the Select Committee on National Expenditure, published at the end of last week, deals with problems associated with the building and repairing of merchant ships. In great part it covers familiar ground, but we print below the recommendations in full and the greater part of a section entitled "Technique, Design, and Research."

Technique, Design, and Research

Technique.—Much publicity has been given to the remarkable records for the quick launching of ships in the new American yards, and the question has naturally been raised in the minds of the public whether these achievements have been due to technical methods which ought to be adopted in British yards. The answer, to which less publicity has been given, is that apart from the "Unionmelt" welding process, the American success has been due less to the use of more modern methods than to the fact that it has been possible to lay out the shipyards with ample space and to organise the industries which supply the yards with a single aim in view—the most rapid production of a single type of ship of one size, propelled by standardised engines and fitted with standardised equipment. The Americans have had, moreover, the advantages of an ample labour supply and no black-out restriction, which no less than the technical advantages have made possible their achievement. Actually, it appears from the evidence that the output per man in tons of steel in the American yards is approximately half the output per man in the British yards.

At the present time several British yards are building merchant vessels by using prefabricated parts for the midship bodies, making the ends and completing the ships. These prefabricated parts account for about half of the total quantity of steel weight in each ship. Other yards will begin building on similar lines at an early date. Welding is being developed to the maximum extent possible in the yards building on this system. Prefabrication has also been applied, wherever delivery will be improved by those means, to items such as masts, ventilator skylights, derricks, &c., which are manufactured in considerable quantities, and are supplied by the Admiralty for incorporation in vessels of normal type, whether being built on Government or private account.

The principal advantage of prefabrication is that, by making use of other than normal shipbuilding labour, it increases the total labour force engaged in the production of merchant ships. From this point of view, it is the policy of the Admiralty to extend the construction of partially prefabricated merchant vessels to the maximum extent. But prefabrication as applied to hull portions does not effect a net saving of labour, as compared with ordinary methods of construction, and may actually be less economical in labour. It thus becomes a question whether it is more advantageous to proceed with a policy which economises shipbuilding labour, but may be more expensive from the point of view of the general labour supply, or whether it would be better to expand the normal shipbuilding labour force by dilution. Your Committee therefore recommend that prefabrication of hull portions should be carefully examined from this point of view.

Many yards, apart from those selected for prefabrication methods, are increasing the use of welding, and the Admiralty have taken steps to make modern types of equipment available. The principal advantages of welding are that it saves steel and that labour can be more easily found for training as welders than as riveters. It is argued, however, that under present conditions the use of welding beyond a certain point does not effect any saving of time, as compared with riveting by skilled squads. Expert opinion seems to incline to the view that in British yards a combination of the two methods will give the best output.

Design and Research.—Experience in the last war showed that slavish adherence to a so-called "standard" ship, which was standard only in general dimensions, but not in constructional detail, gave no advantage from a productive point of view. But, although standardisation of ships in this sense may be ruled out as a means of increasing output in British yards, there is room for a measure of standardisation. Standardisation of sections would enable the steel manufacturers to increase the supply of sections. Something has already been done in this direction, but it could and should be carried further. The same considerations apply to standardisation of fittings.

There has been considerable elimination of non-essentials, but it is the view of many experts that there is still room for simplification. Your Committee recommend that further simplification should be attempted from this point of view.

Between 20 and 25 per cent. of the merchant shipbuilding programme is on private account. For every ship so built a licence has to be obtained from the Admiralty, and the specification is examined to ensure that no unnecessary items are included. Some apprehension has been felt, particularly by the workers in the shipyards, that shipowners are allowed to incorporate in the design of the ship they order features not strictly necessary from the point of view of war service. Your Committee have found no evidence that deviations from Admiralty specification are permitted, except in so far as they are necessary for special trades. Where shipbuilders are building ships of the same type on Admiralty and on private account they are exact duplicates. The contrary belief appears to have arisen from the fact that the standard Admiralty specifications are themselves continually being revised in the light of sailing experience and strategical requirements, and as the result of further efforts to secure economies.

There exists in the records and among the technical members of Lloyd's and of the British Corporation Registers of Shipping a fund of accumulated experience in the design and performance of ships which is unique, and this experience has been drawn on by the Admiralty to effect various economies. These societies have also from time to time suggested ways in which individual designs submitted to them by builders for classification might be improved from the same point of view. Their primary business, however, is to ensure that ships receive a classification which is justified by their safety and seaworthiness and upon which the underwriters can calculate the appropriate premium. In this way they in effect control the standards to which British ships are built, and their rules are frequently revised in the light of experience and technical research. It appears, however, from the evidence of the representatives of the societies that these rules have not been subjected to a general review with the object of seeing how far it may be possible to relax them specifically in the interests of economy and speed of construction. In this respect the British classification societies might well consider a lead already given by the American section of Lloyd's, which body appears

to have accepted standards that would not be permitted in this country. Your Committee recommend that the British classification societies should be asked to review their rules in order to ascertain how far it may be possible to assist production without lowering standards of safety.

The William Froude Laboratory, which is a department of the National Physical Laboratory, exists for the purpose of research into the design of hulls, propulsion, seaworthiness, and manœuvrability. In peacetime it is concerned entirely with merchant shipping, and advises shipowners and builders on their production programme. Its general object is to arrive at designs capable of fulfilling the functions stated and in the most efficient way. To make the contribution of the Laboratory of maximum use in wartime its accumulated knowledge and its service should be available at the very inception of all proposals for building new types of hull. This experience and this service have not always been called upon, and shipbuilders have proceeded to build new types without consulting the Laboratory. The usefulness of the Laboratory has also been limited by the fact that it has not been free to suggest slight variations in Admiralty specifications, directed to enabling the shipbuilder to produce the most effective ship of which the peculiar facilities of his yard are capable. In fine, the resources of this Laboratory have not been fully exploited for war purposes by shipbuilders or by the Department. Your Committee recommend that shipbuilders should be instructed that the National Physical Laboratory be brought into consultation at the appropriate stages in the design of all proposed new types of hull, and that the Admiralty should make the arrangements necessary to secure that full technical liaison is maintained between themselves and the Laboratory.

Before the war the Admiralty was not concerned with problems of merchant ship construction and the procedure whereby these problems are now investigated has been developed in the course of dealing with practical difficulties arising from war requirements. It has been shown above that the resources of the classification societies and of the National Physical Laboratory have not been fully exploited and sufficiently concentrated upon the problems of merchant shipbuilding in wartime. In the field of research proper, the activities of the various institutions concerned, so far from being intensified, have in some respects actually been allowed to languish. These facts seem to justify the conclusion that the Department's present arrangements for directing and co-ordinating research are unsatisfactory. Your Committee therefore recommend the establishment of an organisation with the specific responsibility for directing and co-ordinating all development and research in respect of merchant shipbuilding.

For the distribution of information about improvements in technique and production methods, the Admiralty has special arrangements in the case of naval vessels, but not apparently in the case of merchant vessels. Nor are the means adequate or convenient for ensuring that builders are conversant with improvements made in other yards and engine works, although your Committee found individual instances of such co-operation and were assured that no barriers exist to the exchange of ideas. Your Committee recommend, first, the appointment in close association with the organisation for directing research and development recommended in the previous paragraph, of a technical intelligence staff; and, secondly, that, as is done in warship production, where several firms are building similar vessels, one of them should act as "leader," for each part of the completed ship and machinery, and should be responsible for development and improvement in production technique for that part.

Summary of Recommendations

(1) Training schools for riveters should be set up in the main shipbuilding areas under the management either of the Ministry of Labour or of private shipbuilders in their own yards.

(2) An inquiry should be made by the Ministry of Labour into the experience gained of the employment of women in other heavy industries, as well as in shipbuilding so far as it is available, in order to decide what trades can be carried on by women and under what conditions and what standards of health should be required.

(3) A larger proportion of women in the age group 20 to 30 should be made available for shipbuilding.

(4) Shipbuilders should be pressed to appoint women welfare supervisors, preferably of women trained under the Ministry of Labour's scheme.

(5) Wherever there is insufficient work to keep a shipyard worker fully employed, the employer should be required to report the fact to the local employment exchange, so that, if required, the worker can be transferred.

(6) The Admiralty and the Ministry of Labour should initiate negotiations between employers and workers for the introduction, with the least possible delay, of schemes of payment by results in all yards where these do not now operate and on all kinds of work to which it is possible to apply them.

(7) If workers are not doing satisfactorily the work for which they have been reserved, reservation should be withdrawn, and the yard committees should be given power to recommend dereservation to the National Service Officer.

(8) The Ministry of Labour should use its influence to persuade employers to make the fullest use of yard committees for the discussion of production questions.

(9) The Ministry of Labour should urge and assist the larger firms to appoint properly qualified staffs under a personnel manager with adequate status to administer all matters affecting labour.

(10) Yard committees should be used to remove misconceptions in the minds of the workers which discourage production, and the possibility of giving some facts about shipping losses, not necessarily in the form of a monthly statement, should be reconsidered from the point of view of stimulating output.

(11) The Admiralty should specifically examine the problems and organisation of the slower and more costly shipyards.

(12) Prefabrication of hull portions should be carefully examined from the point of view of economy of labour.

(13) Standardisation of sections and fittings should be carried further.

(14) Further simplification should be attempted from the point of view of eliminating non-essentials.

(15) The British classification societies should be asked to review their rules in order to ascertain how far it may be possible to assist production without lowering standards of safety.

(16) Shipbuilders should be instructed that the National Physical Laboratory be brought into consultation at the appropriate stages in the design of all proposed new types of hull, and the Admiralty should make the arrangements necessary to secure that full technical liaison is maintained between themselves and the Laboratory.

(17) The Admiralty should establish an organisation with the specific responsibility for directing and co-ordinating all development and research in respect of merchant shipbuilding.

(18) A technical intelligence staff should be appointed in close association with the recommended organisation for directing research and development.

(19) Where a number of firms are building similar vessels, one of them should act as "leader" for each part of the completed ship and machinery and should be responsible for development and improvement in production technique of that part.

(20) A review should be made of all yards engaged exclusively on naval work to ascertain whether a small admixture of merchant shipbuilding could be made without substantially interfering with naval work.

(21) The allocation of merchant programmes should be reviewed with the object of reducing the number of types of merchant ships built in the same yard.

(22) A survey should be made of all the shipyards not now in use for shipbuilding, and those should be selected for reopening which could be brought into use in the shortest time.

(23) The possibility of turning over a proportion of repair capacity to shipbuilding should be examined.

(24) The proportion of women in marine engineering should be increased.

(25) The price of merchant ships should be settled at the earliest practicable date, and, if possible, before launching.

(26) The price of repairs should, whenever practicable, be negotiated on a fixed-price basis as soon as the extent of the damage and the amount of work required are known.

The Engineer and Society*

By F. C. STEWART

After the present war the world's capital, productive machinery, raw materials, and skilled labour will be very much greater than after the last, so that the direction of changes in the social and economic world which will inevitably take place is very much the concern of engineers and really of everyone. Owing to the failure in the period of peace of effective demand for goods and the consequent "rationalising" of so many into idleness, engineers, instead of being recognised as benefactors, were accused as enemies, just as in the early days of the power-using age. During the last slump it was in some important quarters actually suggested that we should have a twenty-five years' truce to invention, so that the social sense of the world might have time to catch up with scientific progress. A highly industrialised system is very like a highly powered car, and as dangerous, unless kept under control. Unchecked mechanisation will produce, in the absence of economic and social rearrangements, millions of penurious unemployed who are unable to buy the products of the machines. Herein trained engineers and technicians have a national duty as citizens in seeing that a revival of unemployment does not arise.

It may be alleged that engineers are not fitted or trained in matters of economics and social rearrangements, but, after all, the onlooker may see most of the game, and it may be noted that great reforms did not always come from the inside. For some years after the war, reconstruction will keep engineers fully occupied, the process will be speeded up and the vast machine power existing is likely to be allowed to function fully and without restraint. The urgent reconstructive work will be completed in a relatively short time, and will in all probability be undertaken regardless of cost and at the expense of high taxation. When the reconstruction work begins to fall off the real problems will become evident, and now is the time to consider them. The advice and help of the engineering body, which has made possible enormous productive power, must be added to the efforts of the politicians and social scientists. If they and their work are to survive the dangerous and testing time which will follow the completion of the main work of reconstruction, engineers will have to come out of their professional isolation and take a hand in the wider issues with the post-war planners. The education of engineers has been too narrow in the past; technical education has lacked breadth; cultural matters, citizenship and other liberal arts have been neglected as well as such vital matters as elementary economics. The future may call for a much more liberal education for engineers, so that technicians and engineers may take their proper place in society according to the benefits they have bestowed on humanity.

It might be suggested that engineering is only one section of our national activities, and that there are other equally important industries, but there is no industry the nature of which has not been changed by engineering. Even such basic work as agriculture nowadays depends on engineering products, such as tractors, reapers, and threshers, the hard, grinding toil of the

* From the Presidential Address to the Institution of Engineers and Shipbuilders in Scotland. — October 20th, 1942.

agricultural labourer being eliminated, or at least relieved. It may be that engineers alone are able to assess the importance of their work generally, but it is incumbent on the engineering body to inquire into the reasons why professions, such as accountancy, banking, and the like, appear at present to be held in greater public esteem and respect than the profession of engineering and of science generally. After all, engineers and technicians are producers of real wealth. Accountancy and similar professions have the duty of recording achievements and providing the finance to oil the ways towards achievement, but they alone do not produce real wealth, and without the part taken by the engineer and technician the activities of these professions would largely cease for want of subject-matter.

In my view, the engineer in the past has been a little too much of a specialist. He has been so interested and absorbed by his work that he has had no time, and often no inclination, to interest himself with the world at large. The economic mechanism of the world in the years previous to the present war could not be said to run with the sweet movement and efficiency of a modern power station, and it is probable that the logical and objective training of the engineer would be of great value in national industrial and financial reconstruction. To attain this condition the engineers should have a wider training, and this should include ordinary economics so that he may think in the terms of the economist's own language, and be in a position to criticise the latter's judgments from a practical point of view. There is already a stirring amongst technical educationists, as is shown, for instance, by the recent inclusion by the Institution of Mechanical Engineers of the subject Economics and Workshop Organisation in its associate membership examination. This is undoubtedly a step in the right direction, and should be developed. It may well be that progress could most readily be achieved by a joint conference of technical societies interested in education, so that a pronouncement could be made for the guidance of technical colleges, for if the engineer of to-morrow is to take his rightful place in the world he must acquire the necessary background to-day.

Before the stimulus of wartime production can in any way affect the standard of life, a period of reconstruction must elapse during which the repair of war damage will absorb almost as much of the nation's industrial effort as is absorbed by the war effort at the present period. The return of men from the Services will, of course, increase our ability to tackle this work, but the effort itself cannot be avoided. No manipulation of national finance can minimise the labour in any fashion, although the work cannot be carried out unless a financial scheme is adapted to the project. The liquidation of war savings and insurances will not in itself re-create the sunken ships or the destroyed buildings. The working effort of the community alone can secure this end, and while the effort of the community is absorbed in this manner it cannot be utilised in the supply of the means for a higher standard of living. Consequently, we cannot expect the termination of the war to introduce immediately a golden age, but with a sound national finance and with no slackening or reduction in the industrial effort, then directed to the repair of war damage, the ground can be cleared for happier days. Engineers should be interested and give thought to these matters, as wise guidance during the period of transition to normal times is essential. The material effects of war damage may, in this way, be soon eliminated, although the spiritual devastation will be with us during our generation and many generations to come.

Heavy Duty Horizontal Plano-Milling Machine

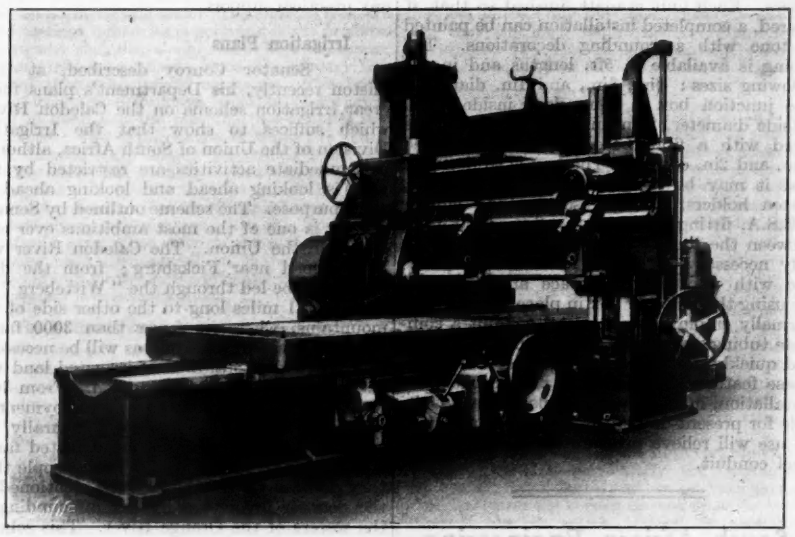
THE machine illustrated herewith is the latest form of heavy duty horizontal plano-milling machine produced by Kendall and Gent (1920), Ltd., Manchester. The capacity of the model illustrated is 5ft. wide by 3ft. deep by 14ft. long. Cutters up to 12in. diameter can be accommodated.

Flat rectangular sectioned slides on a deep, wide bed provide a solid support to the table. The table is also of deep section and has three longitudinal tee slots cut from the solid and two sets of auxiliary side slots. The ways of the table and the bed are chilled and force-lubricated from central wells in the bed.

Positive variable feeds and constant rapid power traverse for setting are provided. Eight changes of feed from ¾in. to 6in. per minute are available. Traversing is effected by a large-diameter worm and semi-circular rack, both of densified iron with a constant flow of oil. The thrust is taken by ball washers. A 5 H.P. reversing motor provides the power through a worm reduction set. The gears are of nickel-chrome steel and slide on six-splined shafts. The table is controlled by means of a lever duplicated on either side of the bed for convenience of operation. This lever is directional—that is, to operate the table at any of the feed rates or rapid traverse it is moved in the direction in which the table is required to travel. Particular feeds are pre-set, but rapid power is obtained immediately by alternative lever positions. Instant stopping is obtained by bringing the lever to the neutral position on the lever gate. Should the spindle stop for any reason the table also stops through the agency of an electrical interlock between the spindle and feed motors. The table can, however, be operated for setting purposes with the spindle stationary.

The uprights rest on the foundation and are tongued and bolted to the bed. A box section cross stay links them at the top. The cross slide can be locked simultaneously on each upright by a lever with compensating mechanism to give equal locking tension. Elevation is effected by hand or by a push button controlled 5 H.P. motor, the hand adjustment being provided with a micro dial.

Support to the spindle and arbor is provided by the spindle head bearings and two auxiliary arbor supports fitted to the angular cross slide face. The conical spindle head bearing is adjustable and is housed in a densified iron sleeve. A lateral movement of 5in. with micro setting is provided. The auxiliary arbor supports are adjustable along the angular face by rack and pinion. The spindle is of heat-treated high-tensile steel, and the arbor of forged nickel-chrome air-hardening steel. The drive from the spindle to the arbor is by shrouded driving flats. A 35 H.P. motor provides the power to the cutters through a nine-change double lever-operated box and a worm and wheel reduction set. The change gears are of nickel-chrome steel and slide on six splined shafts. Speeds from 15 to 53 r.p.m. are provided.



HEAVY DUTY PLANO-MILLING MACHINE

Concrete Bicycle Stands

THERE has been a big increase recently in the use by passengers of bicycles to and from railway stations, and as a result bicycle accommodation has now become inadequate at many stations. The L.N.E.R. has accordingly decided to install bicycle stands of modern design where extra storage is needed. Two types have been adopted : one for erection on open ground, and the other for construction against a wall or the end of a building. Both types are built on the unit principle, so that any number of bicycles from twelve upwards can be accommodated. The units are of prefabricated concrete and have roofs of corrugated asbestos sheets. The method of construction adopted by the company is such that, not only can the stands be erected quickly, but they can be readily dismantled and reassembled elsewhere if required, either in whole or in part.

CONCRETE BICYCLE STAND

A New Insulating Tubing System

THE name "Plasduct" has been given to a new insulating system recently introduced by the General Electric Company, Ltd. It has been produced primarily for use in buildings of

various types, such as Nissen huts, emergency hospitals, hostels, and camps, where close-joint tubing or cleat wiring has hitherto been specified. "Plasduct" tubing is constructed of bakelised paper, and, in addition to being an effective insulator, possesses good mechanical strength, strong resistance to delamination, resistance to corrosion by many chemicals, high resistance to moisture, and light weight.

There are only five component parts in the "Plasduct" system, namely, the tubing, a tubing coupler, a circular junction box, and two covers. Each unit is matt finished so that, if desired, a completed installation can be painted to tone with surrounding decorations. The tubing is available in 5ft. lengths and in the following sizes: ⅜in., ½in., and 1in. diameter. The junction box is 1¼in. deep inside, 2⅜in. outside diameter, 2¼in. inside diameter, and is fitted with a fibre base, $\frac{1}{16}$in. thick, drilled 1⅜in. and 2in. centres. The box is so designed that it may be used for mounting switches, batten holders, ceiling roses, or any similar B.E.S.A. fitting. To make a firm, tight joint between the junction box and the tubing it is only necessary to drill a hole of appropriate size with a carpenter's brace and steel bit. By using the junction box in place of the fitting normally employed with metal conduit a complete tubing system can, it is claimed, be easily and quickly devised with a minimum of parts. These features, coupled with the simplicity of installation, make the system particularly suitable for present-day emergencies. In addition, its use will relieve pressure on the supplies of steel conduit.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, September 12th.

Union's Untouched By-products

THE formation of an Institute for Industrial Research in South Africa, based on a pooling of professional knowledge by industrial chemists, to aid South Africa's war effort, has just been urged by Mr. Louis Volks, a consulting chemist. Mr. Volks established a chemical works at Worcester (Cape) some years ago, but is now acting as a consultant only. He has explained that when he first began business most of his chemicals had to be imported. He tried to find South African equivalents, and in many instances came upon firms that were producing as by-products substances which could be improved and substituted for imports, but this they had not done, simply because there was no demand. Eventually, he was able to use quite a large proportion of South African commodities in his manufactures. "I also came upon kaolin deposits in the Hex Valley," he said. "How many more commodities, by-products, or ores natural to this country are lying untouched simply because we know nothing about them?" he asked, and pointed out that industrial chemists were usually too busy in their own particular line, carrying out research and experimenting, to bother about work outside their particular sphere. Yet each of them might have the germ of an idea which, placed at the disposal of a central body, might prove invaluable at this time, when South Africa is compelled more and more to rely on her own resources. "We may not find the exact counterpart of some commodity which we cannot import," he said, "but we may find a useful substitute.

"Now, if an Institute of Industrial Research were founded, all chemists could collaborate. Ideas could be circulated by the Institute to all members, and, of course, all credits would be given to individual chemists when discoveries were made. Other countries have found this to be a valuable source of profit to their countries, but in South Africa, apart from academic papers read to the Association for the Advancement of Science, there is no research other than that carried out at Onderatepoort or other Government laboratories. I visualise a co-operative ideas exchange between industrial chemists, all members of the Institute, subsidised by the Government and supported by donations from lay brothers. To-day there is a shortage of nicotine in this country. Research may find a source of supply, invaluable to our farmers for spray purposes. Flowers of the veld may yield up rich scents if properly treated. I feel there is unlimited material in this country if we learn to pool our knowledge and work scientifically on the data thus obtained." Much interest has been displayed in the views expressed by Mr. Volks, but it is too soon to say yet whether they will receive any practical support.

Irrigation Plans

Senator Conroy described, at Germiston recently, his Department's plans for a great irrigation scheme on the Caledon River, which suffices to show that the Irrigation Division of the Union of South Africa, although its immediate activities are restricted by the war, is looking ahead and looking ahead to some purpose. The scheme outlined by Senator Conroy is one of the most ambitious ever conceived in the Union. The Caledon River will be dammed near Ficksburg; from the dam water will be led through the "Witteberg" by a tunnel 21 miles long to the other side of the mountains, where no fewer than 3000 farms will be irrigated. Three dams will be necessary in all, and the total area of irrigated land will be from 50,000 to 60,000 morgen. From 7000 to 10,000 people will be given employment in carrying out the scheme, and, naturally, its completion will mean that the irrigated farms will be able to support many more people than they do to-day. Another scheme mentioned by the Senator involves a further impounding of the waters of the Orange River. This scheme will be six times the size of the Caledon River scheme. Obviously, therefore, the engineers are ready with great plans for post-war development. Provided that the new irrigated areas are kept under reasonable control, so that unsuitable crops are not grown under the protection of State-aided irrigation and low State hire-purchase terms, these schemes will be a very great asset to the country.

Escom Report for 1941

The vital importance of the power supply industry to the home front war effort is commented upon by Dr. H. J. van der Bijl, Chairman of the Electricity Supply Commission. "The difficulty and uncertainty of obtaining plant and materials from overseas make it more necessary than ever to maintain the Commission's generating stations at the highest state of efficiency in order to continue to meet the electricity requirements of national essential services," he stated. "This is, however, becoming increasingly difficult under present conditions and restrictions." In all classes of consumers there was an increased consumption during the year. Bulk supplies for mining consumed 3,270,395,982 units, and municipal bulk supplies 312,287,898 units. During the past six years the average price per unit sold by the Corporation has been reduced from 0·266d. to 0·165d.

Total revenue for the first time exceeded £3,000,000. There was an increase in production costs from £2,858,931 to £3,004,520, and the excess revenue over expenditure was only £4154. This represents 0·14 per cent. of the total revenue and is a measure of success achieved in carrying out the general principle of the Electricity Act, that the Commission shall, as far as practicable, operate the undertaking neither at a profit nor at a loss. In the production of the record amount of electricity generated 3,397,838 tons of South African coal were consumed.

Wood Block Tyres

The Southern Rhodesian Road Department is experimenting with the replacement of rubber pneumatic tyres on slow-moving vehicles by wooden blocks fitted into the rims of wheels. Teak and mahogany have proved too brittle and other wood not durable enough, but the knobby thorn has already stood up to severe tests. Tests are also being made to see how bearings react to additional vibration set up by the substitution of wood for rubber. Although wooden tyres are used on slow-moving vehicles, they have so far proved satisfactory even on the driving wheels of power vehicles.

Needs of Union Industries

The Minister of Commerce and Industries for the Union of South Africa has just—September—stated that under a new arrangement South African industrialists will pool their indenting. An Industrial Supply Committee has been appointed and industrial panels will decide the requirements of different factories. These requirements will then be pooled and submitted to the Import and Export Control Board. The Government, the Minister said, would do its utmost to obtain deliveries from oversea, although these could not be guaranteed. Efforts would also be made to eradicate bottlenecks. There was, for example, sufficient material in the country for making men's suits, but there was a shortage of buttons and lining—articles which would not require much shipping space. If the shortage of such articles could be overcome—and supplies were dependent upon the attitude taken up by other Governments—bottlenecks in various industries would be removed.

Union Supplies for Allies

According to information supplied by the Minister of Mines, the Union is supplying the United States of America with manganese, tungsten, chrome, and other metals. Mr. Stallard further stated that his Department is searching intensively for further deposits of tungsten and tin. The production of vanadium in the past has been small, but there are a number of deposits. Tin output during the years 1911 and to 1918 averaged 3000 tons of concentrates annually, but of recent years has dropped to about 1000 tons per annum, the decrease being mostly due to the cost of sending the concentrates overseas, mostly the Straits Settlements, for smelting. The Minister said also that the American mission which has been visiting South Africa has been "examining all our resources and problems of mining gold and base metals. They have been afforded all facilities possible. I think this mutual knowledge is bound to be useful and to give good results." The Minister hoped it would lead to an increase of trade between the Union and the United States; the shipping problem was one of the limiting factors. The Department of Mines is also actively pursuing the search for oil on scientific lines. "We are collecting and collating all the information coming in and a great deal does come in," said the Minister. "Boring in the nature of exploratory work has begun. The possibilities of finding oil are so definite that it would be wrong not to do testing so we are doing it. The legislation passed at the last session of Parliament is proving helpful."

East African Coalfields

The mining conference connected with the development of East Africa's industrial resources for war purposes has discussed the possibilities of the extensive coalfields in Southern Tanganyika. There are two main fields, one in the Ruhuhu, the other in the Ufipa area. The Ruhuhu field contains the better quality and is larger, but it is geographically more difficult of access than the Ufipa field. It is conservatively estimated that from two deposits in the Ruhuhu area 800,000,000 tons are obtainable. Ufipa is 60 miles from Lake Tanganyika. The conference considered that if a railway was provided from the coalfield to the lake the coal could be transported by water to Kigoma for distribution throughout East Africa. The potentialities of the Ufipa field have been investigated and the East African Industrial Development Board is at present inquiring into the possibilities of collecting sufficient rail track to construct a line over the escarpments and the broken country south-east of Lake Tanganyika. Ufipa coal has also been tested by the railways and found suitable, although below imported standard. Preliminary inquiries suggest that Ufipa coal could be landed at Kisumu below the pre-war cost of imported supplies.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer

Contracts for Brass and Manganese Bronze Rods

Since September 21st, 1942, users of brass and manganese bronze rods have been required to submit to the undermentioned authorities details of all orders for such material which they wish to place with manufacturers against contracts which they hold for the requirements of the Admiralty, Ministry of Aircraft Production, or Ministry of Supply (D.A.P. only). The necessary capacity will then be made available by the Central Allocating Committee, and the firm requiring the rods will in due course be informed of the name of the manufacturer with whom the order must be placed and the delivery that will be made. The details required should be sent to the following addresses:—Admiralty orders, the Admiralty, P. Branch Materials, Empire Hotel, Bath; D.A.P. orders, the Ministry of Supply, Non-ferrous Metals Control, Grand Hotel, Rugby; Aircraft Production orders, the Ministry of Aircraft Production, M.P.4, 34, Calthorpe Road, Birmingham, 15. To meet the needs of firms engaged in the manufacture of small components which, by their nature, must normally be manufactured for stock, such firms are permitted to obtain replacement of the brass and manganese bronze rod used in the manufacturing of the orders by submitting their requirements to the appropriate "Service Department," so that an allocation of a source of supply may be given to them. In such cases firms may not wish to replace against such orders the same size, specification, or quality of rod, since they will probably be executing the order from material in stock. These firms therefore are permitted to order any size, specification, or quality in replacement that may best meet their stock requirements at the time, provided always that the tonnage is equivalent to that actually consumed in the execution of the orders in question. Difficulties in complying with the above-mentioned procedure may arise when material is required which it is not possible to identify exactly with particular contracts. In such cases one or other of the following procedures must be followed:—When the material is applicable to more than one "Service Department" and to orders emanating from no other source, and the quantities cannot be broken down for each "Service Department," details of the material required should be sent to the Non-ferrous Metals Control on forms obtainable from this office, when a source of supply will be allocated. When the material is applicable to one or more of the "Service Departments" and/or to orders emanating from other sources, the order for the material should be placed with suppliers as heretofore. "Service Department" contract numbers must not be quoted in support of such orders. The greatest care must be taken by contractors to ensure that the minimum quantities are ordered and that the right delivery period is called for. The provisions of this memorandum do not apply to brass rod requirements authorised by the Bearing Control of the Ministry of Supply, or to brass rods required for the manufacture of bolts, nuts, and screws authorised by the Iron and Steel Control. The term "brass and manganese bronze rods" includes all types of brass rods and sections, extruded, rolled, and/or drawn, *e.g.*, naval brass, high-tensile brass (manganese bronze), and similar alloys, but does not include aluminium-bronze or phosphor-bronze rods.

The Pig Iron Market

The demand has grown considerably since the quarter opened, largely because consumers are disposed to build up stocks wherever possible in order to guard against transport difficulties which may arise during the winter. The demand has been somewhat better of late for high-phosphoric pig iron, of which there are ample supplies, but the most active request is for low-phosphoric and refined irons. Hematite remains in short supply, and the situation in this department does not seem likely to improve, since an increase in production would be dependent upon larger supplies of the ores required for its manufacture, and it is not likely that shipping space will be made available for this purpose so long as the situation does not seriously deteriorate. For some time past hematite has not been released unless it was certain that no other kind of iron could be used for the purpose for which it was required. The consequent run upon low-phosphoric and refined irons has created some stringency in this department, although the careful supervision of distribution which is exercised by the Iron and Steel Control has enabled the wants of consumers engaged upon essential work to be fully met. Some complaints are heard that founders have to be content with unaccustomed mixtures, but for the most part the pig irons which they have been obliged to use have proved satisfactory substitutes for the pig irons they asked for. Consumers, however, do not find it easy to obtain low-phosphoric pig iron unless this is required for essential work, and then the quantities applied for are cut down, if possible. The war demand for engineers' castings and forgings is on a heavy scale and recently the requirements of this section of the industry have been on an increasing scale. The demand from the light castings industries is poor and is the principal reason why such liberal supplies of high-phosphoric foundry iron are available, since this industry is in normal times the largest consumer. The heavy engineering foundries have a lot of Government work in hand and the machine tool trade is well employed. The requirements of these two industries, however, are largely for refined irons, and recently there has been an active market in this description. It is only in cases where its use is absolutely essential that the Control issues licences for low-phosphoric pig iron. On the North-East Coast and some other districts the majority of the furnaces have been placed on the production of basic pig iron for the steel works and large tonnages are passing into consumption.

The Midlands and South Wales

Many of the works in the Midlands are so well booked that they are reluctant to accept fresh business for a long period ahead. This applies in a considerable measure to plates, and although there is no diminution in the demand, it would be difficult to find a producing works able to accept new business for delivery in the current period. The demand embraces all descriptions of plates, but is particularly strong for moderate thicknesses. Plates are wanted in increasing quantities by tank makers, locomotive builders, and shipbuilders, and with the revival of activity in the constructional steel industry a demand has sprung up from that direction for supplies of medium and thick plates. The volume of business in joists and sections is also considerable, and consumers' requirements range over practically all sizes of sections, but chiefly for moderate and small sizes, and delivery dates for these descriptions are becoming extended. The active request for colliery steel is maintained and good supplies of arches, roofing bars, &c., are reaching the collieries. This demand, which has been on a considerable scale for many months, shows no signs of falling-off. The aircraft and munition makers are still eager buyers of special and alloy steel. Production is at the maximum, but so much is required that further supplies, were they available, would be taken up. The iron and steel industry in South Wales is fully employed. As in other districts, the demand is particularly noticeable for ship, tank, and boiler plates. Important tonnages of billets are being turned out by the steel works and are passing immediately into consumption. The whole production of sheet and tinplate bars is also quickly taken up. The tinplate trade, however, remains dull and the volume of business in tinplates or substitutes is unsatisfactory. Business in sheets is moderately active, the output being concentrated upon black and painted sheets, which are required in increasing quantity for the erection of military huts. There is an active business passing in joists and sections, and makers have lately received an influx of new orders.

The North-East Coast and Yorkshire

All the steel works on the North-East Coast are operating at capacity, largely upon high-priority orders, and the demand, which has been insistent for some time, seems to be growing. Consumers' requirements cover all branches of finished products, and with the increased call for these there has been a corresponding expansion in the request for semis. By great efforts production has been raised to even higher levels than the British works achieved during the earlier part of the year, but it is still necessary to rely to some degree upon imported semi-finished materials, although imports of this description are upon a greatly reduced scale. The character of the demand does not greatly vary, and the outstanding features remain the call for steel plates of all thicknesses and for alloy and special steel. The latter is required in considerable quantities by aircraft and armaments manufacturers, and, wherever possible, production is being increased. At the same time, so great is the pressure from consumers that the latter are being continually urged by the Control carefully to collect and segregate all alloy scrap arising in their shops. Lately, fresh orders for plates have been placed by the locomotive makers on a considerable scale, whilst there is a continuous stream of deliveries of plates to the tank makers. The constructional engineering industry also is showing more interest in this class of material. The situation in the structural steel department compares favourably with that ruling only a few months ago. A considerable volume of business is passing in light sections, but there is an improved request for heavy joists, although these are able to be supplied at comparatively short notice by most of the producing works. Some reports from the Yorkshire steel-making districts indicate that the demand has become easier and that the steel requirements of the various Government Departments have been largely covered In other respects the situation is satisfactory.

Scotland and the North

Outputs at the Scottish iron and steel works are well maintained, and as the raw materials position is satisfactory it is probable that production will be at a high level for the remainder of the year. The works have a large tonnage of orders in hand, sufficient, it is believed, to keep the industry well employed for the next six months. The demand for plates keeps the mills in full operation and consumers' requirements, particularly the shipbuilders and tank makers, seem to be increasing. Whilst the delivery dates quoted by some works are being extended, on the whole consumers' requirements are well taken care of, and firms engaged on essential work are not being held up for lack of material. The armaments trades continue to take up important quantities of alloy steels, which are required in increasing amounts for military equipment. A heavy volume of business is passing in structural steel, although the call is more for the lighter than the heavier sizes. Producers, however, report that consuming trades, particularly the shipbuilders, are asking for a large number of various sizes, which increases the burden thrown upon the works. There is also an active demand for shell steel, which, however, is being adequately met by the works. There is an important production of steel bars, and the demand for the heavy sizes appears to be expanding. The re-rolling industry is also kept fully employed on the production of small steel bars, but with good supplies of billets the works are fully meeting consumers' requirements. Although the business passing in reinforced concrete rods has declined lately, the works have a good tonnage of orders in hand. In the Lancashire market the situation has not materially changed during the past week or two. The pressure of demand is chiefly noticeable in the plate department. These are required in big quantities by the tank makers, locomotive builders, boiler and wagon makers. Producers are making a great effort to meet consumers' requirements, and the tendency for delivery dates to expand appears to have been held in check, although most makers would be reluctant to accept fresh orders for delivery during the current period. The pressure to obtain special and alloy steels has caused the manufacturers to modify specifications. This may limit the number, with a view to easing the situation. The steel industry on the North-West Coast is fully employed and the works have a good reserve of orders on their books. A very large proportion of the work in hand is on Government account.

Iron and Steel Scrap

Reports have been current recently that cargoes of scrap are to be shipped from Great Britain to America. These reports appear to have emanated from the United States but it can be stated that they are without foundation. The demand for scrap in this country remains on a heavy scale and there is a particularly strong request for heavy steel scrap in furnace sizes. Merchants are doing their best to meet the call, but the demand is in excess of the supply. Consumers are also complaining that so much of the scrap now offered them is of an inferior quality. The demand for the lighter descriptions of steel scrap has been better recently, but business has been slow, since the tonnages available are well in excess of users' requirements. The volume of business in steel turnings has been rather light, although there have been large quantities available—more, in fact, than consuming works were prepared to accept. In fact, generally speaking, most of the works seem to have considerable stocks of the inferior grades and to be ready buyers of higher qualities. Ironfoundries are obtaining fair supplies of scrap for use in the foundries, but it is stated that licences for cast iron scrap are not being granted freely, and that the quantities asked for in the applications are frequently reduced by the authorities. On the other hand, large quantities of lighter descriptions used in the blast-furnaces are available in quantities in excess of consumers' requirements. Cast iron borings are being taken up satisfactorily. A feature of the market is the scarcity of machinery metal, which has been offered and consumers are finding that a large proportion of the material offered them consists of railings scrap.

Notes and Memoranda

Rail and Road

NEW U.S.A. ROUTE FOR TRANSPORT OF IRON ORE.—The Government of the U.S.A. has approved the spending of 20,000,000 to 30,000,000 dollars to provide an alternative route across the upper peninsula of Michigan for iron ore shipments in order to provide a second traffic route and ensure against the closure of the locks at Sault Ste. Marie. The project calls for the construction of ore yards, docks, and dredging at Escanaba, Mich., and improvement of railways and railway bridges.

TANGANYIKA COAL.—Problems arising out of schemes for the development of vast coalfields in Southern Tanganyika, which have hitherto been handicapped by their remoteness from economic transportation, were discussed at a recent mining conference in Nairobi. The proposal now being officially examined provides for a railway from Ufipa to the shores of Lake Tanganyika, which will enable coal to be distributed throughout East Africa by lake and rail transport. At present there are no coalfields operating in these territories, and all requirements are imported.

THE TRANS-CANADA HIGHWAY.—Now that the final linking up of a number of provincial highways has been completed, the question of maintenance has arisen. The appropriate Minister in Ontario has disclaimed any interest in the suggestion that the Dominion Government should maintain the Trans-Canada Highway. In the United States for many years there has been a system of fixed contributions made by the Federal Government to certain classes of highways throughout the United States. The actual work, however, both in building and maintaining is done by the State Departments.

BRUNORISING.—This is the name given in the U.S.A. to a new heat treatment applied to rails. In this process the rails are allowed to cool after rolling in the normal way to about 480 deg. Cent., and are then reheated in a furnace, under accurate and uniform temperature control, to a little over 800 deg. Cent.—that is, above the critical temperature of the steel—and at this temperature they are held for a sufficient length of time to ensure uniformity of temperature throughout the rail section. After this treatment, they are removed to the hot bank and allowed to cool normally. Brunorising has the advantage of improving the physical properties of the steel.

Air and Water

SALVAGING A TRAIN FERRY.—In February last a train ferry of the Swedish National Railways was sunk by a mine while plying between Trelleborg and Sassnitz. Lacking the necessary gear, the Swedish authorities have entrusted the salvaging to a German concern. The ferry was the only vessel of the ice-breaking type owned by the Swedish State Railways, and had a carrying capacity of twenty-five loaded wagons, as compared with the fifteen wagons each which the other two Swedish train ferries on that route can handle. In an endeavour to save the ship when it was mined, six of the twenty-three railway wagons then on board were jettisoned, but to no avail.

THE ST. LAWRENCE WATERWAY.—Writing recently to a Republican Senator, President Roosevelt, who has supported the St. Lawrence project all along, expressed the opinion that "it is indeed unfortunate that the St. Lawrence project is not now a reality to aid in strengthening both the United States and Canada in the task of winning the war." The President made a special reference to the Champlain cut-off, as a means of "eliminating considerable danger now due to the submarine menace and developing permanently a mighty resource which will add immeasurably to the safety and welfare of our country." The Senator, who blames the railway companies and certain power concerns for the hold-up, claimed for the cut-off that it would have permitted American vessels to avoid 1000 miles of submarine-infested waters by sailing up the St. Lawrence River and down Lake Champlain and the Hudson to New York City.

AERO-ENGINES GENERATE POWER TO BUILD THEMSELVES.—From information furnished by the Henry Ford interests it would appear that more than half of the electrical power required in the manufacture of American Ford-built aircraft engines is produced by the engines themselves. This method of saving fuel has reduced by 53 per cent. the actual power costs of producing the 2000 H.P. Pratt and Whitney engines made in Ford's new aircraft engine plant at Ypsilanti, Michigan. The name adopted by Ford engineers for this method is typical of American nomenclature. It is the "bootstrap system," because the factory figuratively lifts itself by its own power bootstraps. The method is comparatively simple in operation. As each engine is transferred from the assembly line to a testing cell, a hydraulic constant-speed coupling, linked to a generator, is attached to it. As the engine undergoes several hours of test, the otherwise wasted power generated by it is recaptured.

Miscellanea

THE DE HAVILLAND AIRPORT IN CANADA.—The runways of the airport at the plant of de Havilland Aircraft, of Canada, Ltd., in Central Ontario, will be more than 2 miles long and will cover an area greater than that of 18 miles of standard surfaced highway, when they are finished. This airport will be one of the largest and finest in Canada, covering, as it does, 270 acres.

CANADIAN MAGNESIUM.—The new Government-owned plant of the Dominion Magnesium Company, situated near Renfrew, Ont., is now in operation, and Canadian-made magnesium is available for the first time. Canada's entry into the field is based on the discovery of the new Pidgeon ferro-silicon thermal reduction method applied to the dolomite deposits at Haley's Corners, near Renfrew. The new enterprise has cost nearly a million pounds.

SILVER IN PLACE OF TIN.—The American Silver Producers' Research Project is investigating again the prospects of using the metal in electro-plated form as a lining of containers for a variety of purposes. Other activities of the Project have, for the time being, been suspended, but this particular development has been followed up, and, it is reported, has now reached the stage at which it could be applied. It is now practicable to manufacture relatively low-cost silver-lined containers such as barrels, drums, and cans. The pore-free silver deposits, a thousandth of an inch in thickness, which are readily obtainable, are claimed to be adequate for most container applications.

Personal and Business

MR. R. G. WICKHAM has been appointed senior locomotive superintendent, Gold Coast Government Railway.

THE GREAT WESTERN RAILWAY announces that Mr. A. E. C. Dent has been appointed road motor engineer, Paddington.

MR. R. C. VAUGHAN, president of Canadian National Railways, has been appointed chairman of the board of directors in succession to Mr. S. J. Hungerford, who has retired.

W. P. BUTTERFIELD, Ltd., engineers and tank manufacturers, Shipley, have opened a London office at Africa House, Kingsway, London, W.C.2. This office will be in charge of Mr. J. C. Dudgeon, one of the company's directors.

AT the request of the Minister of Supply, Mr. G. S. Szlumper, C.B.E., formerly general manager of the Southern Railway, has accepted an appointment on an honorary basis as Director-General of Supply Services in succession to Mr. J. C. Patteson. It will be recalled that Mr. Patteson was recently appointed Ministry of Supply Representative in Canada.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Austrian Engineers, Chemists and Scientific Workers in Great Britain

Monday, Nov. 16th.—Inst. of Structural Engineers, 11, Upper Belgrave Street, S.W.1. "Recent Developments in Lubrication," L. Rosenfeld. 7.15 p.m.

Bradford Engineering Society

Monday, Nov. 23rd.—Technical College, Bradford. "The Diesel Engine," J. G. Jagger. 6.45 p.m.

Fuel Luncheon Club

Thursday, Nov. 19th.—Connaught Rooms, Great Queen Street, W.C.2. Address, Sir F. Handley Page. 12.40 for 1.10 p.m.

Institute of Fuel

Saturday, Nov. 14th.—MIDLAND BRANCH: Grand Hotel, Birmingham. Discussion, "The Battle of Fuel in Industry." 2.30 p.m.

Institute of Transport

Saturday, Nov. 21st.—METROPOLITAN GRADUATES: Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Public Co-operation in Transport," J. E. Cowderoy. 2.15 p.m.

Institution of Automobile Engineers

Sunday, Nov. 15th.—LONDON GRADUATES: 12, Hobart Place, S.W.1. "Cross Rotary-valve Engine Development," J. Jack. 2.30 p.m.

Institution of Civil Engineers

Tuesday, Nov. 17th.—RAILWAY ENGINEERING DIVISION: Great George Street, Westminster, S.W.1. "Railway Signalling and Communications," A. E. Tattersall. 5.30 p.m.

Tuesday, Nov. 24th.—ROAD ENGINEERING DIVISION: Great George Street, Westminster, S.W.1. "The Construction of Bases for Roads and Aerodromes Using Local Aggregates and Soils," A. H. D. Markwick and H. S. Keep. 5.30 p.m.

Institution of Electrical Engineers

Saturday, Nov. 14th.—N. MIDLAND STUDENTS: Griffin Hotel, Boar Lane, Leeds. "Telecommunications of the Future," W. G. Radley. 2.30 p.m.

Tuesday, Nov. 17th.—WIRELESS SECTION: Savoy Place, Victoria Embankment, W.C.2. Discussion, "Plastics in Radio Production." 5.30 p.m.

Friday, Nov. 20th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "A Differential Electronic Stabiliser for Alternating Voltages and Some Applications," A. Glynne. 5.30 p.m.

Monday, Nov. 24th.—Informal meeting. Savoy Place, Victoria Embankment, W.C.2. Discussion, "The Electronic Control of Industrial and Power Plants." 5.30 p.m.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Some Factors Affecting the Design of Alternators for Switchgear Testing," V. Easton. 6.15 p.m.

Institution of Engineers-in-Charge

Saturday, Nov. 14th.—Magnet House, Kingsway, W.C.2. "Infra-Red Lamp Heating," F. E. Rowland. 2 p.m.

Institution of Mechanical Engineers

To-day, Nov. 13th.—Storey's Gate, Westminster, S.W.1. "Utilisation of Exhaust Steam for Agricultural and Industrial Uses," L. A. Ferney. 5.30 p.m.

Saturday, Nov. 14th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester. "Recent Developments in Refrigeration," Lord Dudley G. Gordon. 2.30 p.m.

Monday, Nov. 16th.—MIDLAND GRADUATES: Watt Memorial Institute, Great Charles Street, Birmingham. "High Test Cast Iron as a Substitute for Steel," E. Hunter. 7 p.m.

Friday, Nov. 20th.—Storey's Gate, Westminster, S.W.1. "Caustic Embrittlement," E. W. Colbeck, S. H. Smith, and L. Powell; "Corrosion of Boiler Tubes," T. Henry Turner. 5.30 p.m.

Institution of Mining and Metallurgy

Thursday, Nov. 19th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "The Leaching of Cupreous Pyrites and the Precipitation of Copper at Rio Tinto, Spain," J. H. Taylor and P. F. Whelan; "Note on the Nando Gold Mine, Umsweswe," S. J. Nathan. 2.30 p.m.

Institution of Production Engineers

Saturday, Nov. 14th.—YORKS SECTION: Great Northern Hotel, Leeds. Discussion, "The Young Production Engineer: His Training and His Prospects." 2.30 p.m.

Iron and Steel Institute

Tuesday, Nov. 17th.—Modern School, Cole Street, Scunthorpe. "The Linings of Large Basic Open-hearth Tilting Furnaces," A. Jackson; "Investigations on 'Falling' Blast-furnace Slags," T. W. Parker and J. F. Ryder. 7.30 p.m.

Junior Institution of Engineers

To-day, Nov. 13th.—39, Victoria Street, S.W.1. Annual general meeting. 6 p.m.

Friday, Nov. 20th.—39, Victoria Street, S.W.1. "Appointments Department Within the Ministry of Labour and National Service," E. W. Hoyle and A. C. R. Ritchie. 6 p.m.

Keighley Association of Engineers

Friday, Nov. 20th.—Victoria Hotel, Keighley. "The Substitution of High-duty Grey Iron for Steel Castings," J. Blakiston. 7.30 p.m.

Manchester Association of Engineers

Saturday, Nov. 21st.—Engineers' Club, Albert Square, Manchester. "Exhaust Pipe Phenomena," G. F. Mucklow. 2.30 p.m.

Manchester Geological and Mining Society

Monday, Nov. 16th.—Midland Hotel, Manchester. "Power Loading Underground," W. H. Richards. 2.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Monday, Nov. 16th.—Mining Institute, Newcastle-upon-Tyne. "The Water-tight Subdivision of Merchant Ships, with Special Reference to the Use of a Water-tight Deck," W. Muckle. 6 p.m.

Wednesday, Nov. 18th.—STUDENT SECTION: Bolbec Hall, Newcastle-upon-Tyne. "Marine Boiler Design," E. H. Frank. 6.45 p.m.

Royal Society of Arts

Monday, Nov. 23rd.—John Adam Street, Adelphi, W.C.2. "Thermal Insulation at Medium Temperatures," A. C. Pallot. 1.45 p.m.

Society of Chemical Industry

Friday, Nov. 20th.—MANCHESTER SECTION: Grand Hotel, Aytoun Street, Manchester. "Why is Rubber Elastic?" L. R. G. Treloar. 2 p.m.